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MACHINE TOOLS AND METALWORKING EQUIPMENT

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USSR REPORT

Machine Tools and Metalworking Equipment

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TECHNOLOGICAL FEATURES OF FMS, UNATTENDED SYSTEMS DISCUSSED

FMS Support Systems Described

Moscow MASHINOSTROITEL in Russian No 5, May 86 pp 16-18

[Article by Candidate of Technical Sciences A. A. Panov under the rubric "The Mechanization and Automation of Production": "Technological Features of Flexible Machine Systems"]

[Text] The loading and unloading of parts by industrial robots in servicing machine tools with numerical control [NC] is one of the principal areas for raising the efficiency of machining production and facilitates the creation of automated closed-product machine-tool sections for the incorporation of fully automated production.

The automation of machining production includes two ways of improving it: the creation of comprehensive automated computer-controlled machine-tool systems and the incorporation of unattended production. Both the first and the second ways permit an increase in productivity thanks to flexibility in production and a reduction in manual-labor expenses. The first system, furthermore, can support unattended machining in series and mass production.

It facilitates an improvement in the resetting and servicing of machine tools, the expansion of the process capabilities of each individual element of the system and the efficient manufacture of a variety of parts of small standard sizes.

The specialization and programming of production at the plant serve as the first step in considering the question of incorporating comprehensive automated computer-controlled machine-tool systems. The fundamental principle of these systems is the presence of closed-product machine-tool sections and the centralized control of all of production.

The logical incorporation of NC equipment in a closed-product section can be organized into automated production. The principle of creating comprehensive automated computer-controlled machine-tool systems differs considerably from the system of numerical control for a group of machine tools with one computer

which controls in a centralized fashion and ensures flexibility and adaptability to the production of a variety of small-sized parts with the least number of work personnel.

Three characteristic factors must be noted in unattended production: the rapid resetting of production for the manufacture of a variety of parts; the operational reliability of the built-in equipment; and, the monitoring of the condition of the equipment so as to avert accidents and ensure equipment safety and the quality of the machined parts. The principle of unattended manufacture is a further step on the road to improving the automation of metalworking, but it is expedient to incorporate unattended production at enterprises that have experience in the operation of machine tools with NC.

The principal distinction of machine tools operating on the principle of unattended manufacture from traditional NC machine tools is that the former are also equipped with automatic loading and unloading apparatus and various diagnostic apparatus for monitoring serviceability.

When incorporating production operating on the principle of unattended manufacture, it should be taken into account that it does not turn out to be profitable in all cases. Analysis shows that the lowest cost per unit of product output is characteristic of automatic lines, and the highest with NC machine tools. The cost of resetting the equipment is in an inverse relationship to the output of new products. The economic efficiency of the incorporation of unattended production should be evaluated by comparing it with production using traditional NC machine tools. Both types of production require the feeding of blanks, the timely replacement of the cutting tool and the monitoring of the quality of product output and maintenance. There is somewhat of a difference in the organization of their shops in that in unattended production, heating in accordance with health norms is not required; a decreased supply of electric power can be envisioned here at night. For the same level of product output, unattended production will occupy less space and require smaller reserve stocks of products. The parts production cycle is also less here, insofar as there are no breaks associated with rest for support personnel.

The realization of all of the advantages of unattended production leads, however, to the fact that the cost of fixed capital turns out to be greater than for production using traditional NC machine tools. Unattended production requires additional apparatus for control, monitoring, transport and loading equipment, as well as an expanded computer network. One of the methods of incorporating unattended manufacturing is the modification of existing production using NC machine tools.

The economic efficiency of automated apparatus is greater when its longevity is greater and idle time is less. Insofar the use of modern equipment is envisaged in flexible production, the time for resetting also enters into the economic calculations. The basic rule, however--that one day the adjusted part should be transferred only purposefully from process stage to process stage--has decisive significance in the movement of materials in automatic production (from blank to finished part).

For reorienting the part in servicing multiple machine tools, pallet transport systems can be utilized effectively. They allow the parts to be turned, but are, however, insufficiently flexible and are usable only for parts with simple defined contours.

The use of transportation apparatus of a single type is important, if only from the point of view of maintenance. The transport systems should not cram the workspace and hinder the servicing of the machine tool, the replacement of the tool or the setup procedure. The process of materials transportation includes such important elements as the cleaning of the parts, their sorting into usables and rejects and their reorientation into the required position. These systems are basically divided into two types, for the transport of vee blocks or rotating-body type parts, but notwithstanding this fact, they invariably have roller conveyors, hydraulically or mechanically powered gantries, a robot or special loader and coded or uncoded pallets.

In many cases the part, after rough machining, must be released and secured anew before finish machining, so as to diminish the stresses that appear as a result of machining. Automatic reclamping is various positions causes great difficulties, and therefore the solution arises of shifting the pallets into special positions.

The distribution of the blanks (parts) flow in unattended production is the second task after the resolution of the problem of manipulating the tool. A most important problem is determining the instant of tool breakdown or dulling, the wearing out of the alloy tip in precision boring and its timely replacement before the end of the tool life.

The transporting of the tool from the warehouse or the sharpening department to the machine tool, the refilling of the dispenser and the automation of locations for the preparation of tool sets for the corresponding parts are other important tasks. The correct choice of machining process has a great effect on the economy of the whole flexible production system.

Determining the position of cast parts and measuring them during the machining process and in resetting, verification testing, sorting the parts by groups according to precision and determining the need for additional machining are all tasks of comprehensive measurement in the machining process. Electronic measuring apparatus makes it possible to carry out computational evaluations of the process, and therefore their application is an optimal solution. The efficiency of quality control is evaluated as highly as the efficiency of machining and the movement of blanks.

Group manufacture as applied to metal-cutting equipment initially received widespread distribution. It has currently been disseminated to other spheres of production. Machine-tool systems constructed on the principle of group manufacture passed through three stages of development. At the first stage it was a system that incorporated one machine tool, at the second stage multiple machine tools, and at the third stage it was a system that included installations for heat treatment, the application of coatings, painting etc. as well as machine-tool equipment.

The concept has arisen of grouping parts in sets that are characterized by machining processes that have similar manufacturing parameters. These requirements are met by a multiple machine-tool system for the machining of various parts combined into one process group. In this case, the section operates on the flow-line principle, in which the part passes through all of the stages from blank to finished product. Principles for planning shops currently exist by way of dividing them into product-specialized sections that are created on the basis of group manufacture and the analysis of production flows at existing enterprises, which ensures the maximum saving from the use of group manufacture principles. This saving can be obtained when production spaces are broken up in planning into individual sections within the framework of which all operations for the complete machining of homogeneous parts are executed.

The product-specialized section encompasses single and multiple machine-tool systems, including systems of NC machine tools. Parts machining in such sections is characterized by relatively low time expenditures for setup work, high utilization factors for the machine tools and high economic efficiency.

The basic technical and economic characteristics of sections constructed on the principles of group manufacture are determined to a considerable extent by the degree of homogeneity of the parts. A theory exists according to which there should be one principal machine tool in a product-specialized section on which the initial operations of the machining of every part in the lot should be executed. The other machine tools and equipment are chosen in such a manner that they execute the remaining operations necessary for obtaining a finished part. In this manner, the principal machine tool determines the maximum productivity of the section, and in order to obtain the highest overall utilization factor for the equipment of the section it is essential to ensure the maximum utilization factor for the principal machine tool.

It is economically expedient in a number of cases to single out a section in the shop for final finishing operations (heat treatment, painting, coating and the like) that should provide for the appropriate machining of the parts that arrive from individual product-specialized cells where only mechanical machining is executed. The product-specialized section is relatively small with the narrow specialization of the process operations performed. Therefore the foremen, setup workers and machine-tool operators have the opportunity of mastering the fine points of the process support equipment and the operations performed. Apart from the positive effect of this circumstance on the quality of product output and the efficiency of machining, a favorable social climate is created in the section and its personnel feel satisfaction from the work performed.

We will consider a practical approach to the creation of unattended production in a comprehensive automated computer-controlled machine-tool system at a plant of the Fujitsu Fanuc firm (Japan). The closed-product machine-tool system is a basic element of unattended production here, consisting of NC machine tools, automatic parts loading and unloading apparatus and monitoring equipment.

Two types of closed-product machine-tool systems are utilized: an industrial robot is used in one, and an apparatus for the automatic replacement of auxiliary attachments is used in the other. The unattended nature is provided for by three factors: mechanical machining using NC machine tools; parts loading and unloading with the aid of an industrial robot or an apparatus for the automatic replacement of auxiliary attachments; and, monitoring for defects in the operation of incoming equipment.

The closed-product machine-tool section can work without an operator when the control programs are fully prepared and the quantity of cutting tools in the tool dispenser and blanks loading are fully planned. A robot or auxiliary attachment automatically loads and unloads the parts, and the NC machine tool continuously executes the mechanical machining operation in accordance with the control command data stored in memory. If the reverse-communication sensor detects something wrong in operation during mechanical machining, the closed-product machine-tool section is automatically halted. Thus, the closed-product machine-tool section is a completely automated machining system in which a single operator services several machine tools. He carries out the following preparatory functions: preparing the control commands and their transfer to the control-program library; loading the cutting tools in the dispensers and regulating them; preparing the clamping attachments and the tooling; instructing the robots; delivering blanks to the feeder (dispenser); and, monitoring the parts machined on the machine tool. The operator conducts these operations for every machine tool. In the case of unattended production on the night shift, he makes a request for the preparation of parts in advance, obtains confirmation and in addition regulates the setting up of the cutting tools and equipment.

The memory used in the control system is a small unit for storing information in case of electric-power disconnection and is sufficient for storing the amount of control commands essential for the production of a variety of small-sized parts.

Three types of industrial robots with lifting capacities of up to 10, 25 and 50 kilograms can be used for loading and unloading and the movement of parts in closed-product machine-tool sections. They are characterized by reliability in operation as well as flexibility from the point of view of loading a broad range of machined parts moved either by the hand or gripper; flexibility of the programmable manipulator in the method of instruction and execution, that is, the modifications of movements and the selection of mutually exclusive loading programs (in other cases the parts are machined in the auxiliary attachment); reduced waiting time on the machine tool; and, a reduction in manual labor and increased productivity. The industrial robot is more economical than standard-design loading apparatus.

High reliability is an exceptionally important characteristic for unattended production. The reliability of the moving operations is linked to the preparation of the corresponding control commands; the uniformity and stability of blanks (parts) sizes and their geometric shapes; the life of the cutting tool; and, the ability of the tooling to be reset and the stability of the cutting modes.

Monitoring machining error and safety measures are of considerable significance in unattended production. The principal items of monitoring are operator safety, the upkeep of the working apparatus of the system in operating condition in order to avert any errors that can provoke unsafe consequences, and the maintenance of high quality in the parts inspected.

The cutting-tool monitoring system determines the condition of the tool so as to detect damaged or dulled tools. The monitoring is carried out by observing deviations in the load on the spindle drive during the cutting process. The life of the cutting tool is also monitored with the registration of the effective cutting time. When the optimal degree of cutting-tool wear is reached, a signal to stop the drive is issued.

The principle of the comprehensive automated computer-controlled machine-tool system in machining production can be considered a combination of closed-product machine-tool sections with an automated warehouse and a parts-and-blanks transportation system. The principle of the comprehensive automated machine-tool system consists of centralized control with the distribution of machining processes to work sections. A planned schedule based on production orders is sent by televised communication line to the controlling computer which makes the order for the delivery of the blank. Control of the arrival of the blanks and parts is implemented by a central control system. The control computer processes the condition of these parts before final inspection and shipment.

Machining is fully automated on the first day shift: several operators carry out only preparatory operations. The system required a 30 percent increase in capital investment for robots, while at the same time the productivity of the closed-product section increased by 10-20 percent (as a result of the use of robots for loading and unloading operations) and the number of operators was reduced by 50 percent. Operators were practically not needed on the second and third shifts. This made it possible to achieve an increase in labor productivity of 70-180 percent for each closed-product section. Without operators, the productivity per machine tool can be doubled or tripled, which allows a reduction in the cost of parts manufacture.

On the day shift, such production is supported by operators and controllers in the machining and assembly sections; a single controller works on the night shift. Every operator in the mechanical shop on the day shift services five closed-product sections, being occupied with preparatory operations.

Insofar as the ratio of the productive capacity of the day shift to the night shift is 1:1 and one machine-tool operator supports two NC machine tools, labor productivity in the closed-product machine-tool section is reduced for one and the same amount of work.

A comprehensive automated system based on the use of closed-product machine-tool sections considerably facilitates an increase in labor productivity, a reduction in manpower and the more efficient utilization of capital investment thanks to the application of unattended production in machining shops, especially on the night shift.

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Tula Management System Described

Moscow MASHINOSTROITEL in Russian No 5, May 86 pp 18-19

[Article by Yu. M. Agafonov, A. L. Besedin and Yu. B. Lebedev: "Flexible Automated-Planning Complexes--A Way of Developing the Intensification of Production"]

[Text] There are several collectives in Tula Oblast that are resolving tasks of production management skillfully using a scientific approach to the organization of labor. The well-known Shchekino method of raising labor productivity with the simultaneous reduction of the number of personnel can serve as an example.

An especial area in raising the efficiency of the economy in the oblast is the struggle to raise product quality. Productive ways and methods have been determined today that allow the achievement of good results. The enterprises of the oblast, having begun work in this area using the Saratov system of defect-free labor and having accumulated a certain experience, can set about the broad incorporation of a comprehensive management system according to the experience of Lvov Oblast. The labor collectives of the cities of Tula, Novomoskovsk, Shchekino, Yefremov, Aleksin, Kimovsk, Uzlovaya and Kireyevsk, whose products go to all corners of our country and abroad, work under the slogan "Tula--means excellent". By the end of the 10th Five-Year Plan, comprehensive management systems of product quality were incorporated in 118 enterprises, associations and organizations. An economic saving of 24.5 million rubles was obtained as a result.

Considerable work in systematizing the experience of the machine-building enterprises of the city of Tula and the oblast for the creation of a quality management system for planning and design developments making broad use of technical equipment complexes, included automated planning systems, is continuously being carried out by the oblast board of NTOmashprom [Scientific and Technical Society of the Machinery Industry]. Research was conducted on the formation of an organizational economic mechanism for managing the quality of planning operations, analysis of the effect of the quality of the planning process on the quality of plans overall, formulating a norms and reference base for the system, forecasting the quality of developments, calculating in a comprehensive manner the economic efficiency of the system for managing the quality of planning operations and the like.

Definite results were obtained in the oblast in the automation of production processes. It is sufficient to cite the example of the incorporation of industrial robots at the Tula Machine-Building Plant imeni V. M. Ryabikov. Robots are used there for mechanical machining, assembly and welding operations, and hot and cold die forging. The robot-equipped line for the assembly and welding of wheel hubs for a freight motor scooter, for example,

includes three automatic welders for arc welding in a carbon-dioxide-gas medium, a straightening installation, six Tsiklon-3B industrial robots, a Universal-5.02 industrial robot and three types of loading apparatus. The robots transport parts and bearings to the appropriate positions on the automatic welders, where assembly and welding are executed, as well as place the welded assemblies in special packaging.

The widespread utilization of the comprehensive system for managing product quality in Tula Oblast suggested that the principles of the systemic approach to the problem found at the enterprise should be employed in resolving tasks of economic and social development of the collective overall--to link these tasks in a unified complex. Thus was born the Tula Comprehensive System for Managing Work Quality and the Economic and Social Development of the Collective (KSUKREiSRK). This system is aimed at raising the level of management and executive discipline and, in the end result, at raising production efficiency, as well as at the successful resolution of social questions and the cultivation of the creative activity of the laborers.

The functioning of the comprehensive system at all levels of the enterprise is ensured by a coordinating council and workers' groups specialized by structural subunits. Thus, it permits the broad inclusion of the laborers in the management of production. The chief virtue of the KSUKREiSRK is that it makes it possible to evaluate objectively the quality of labor and the level of executive discipline from the lowest worker up to the director, and based on that to place material incentives and labor measures in precise and justified dependence, which fully meets the spirit and substance of socialist distribution.

This system was incorporated and tested at several Tula machine-building plants. Its utilization permitted an appreciable increase in the volume of production and labor productivity along with a reduction of lost work time and a raising of executive discipline.

Based on the dedicated-program planning method, the comprehensive system for managing work quality and the economic and social development of the collective is a practical and exceedingly effective control over the further improvement of the management mechanism. The system possesses great universality and flexibility and can be used at enterprises and organizations of various sectors of the national economy. But that is not the only advantage of the KSUKREiSRK. It should be noted that the comprehensive system, on the one hand, penetrates to all levels of production preparation and product output and, on the other hand, the technical-standard documentation developed for the KSUKREiSRK allows the realization of this system by computer in the future.

The factors noted make it possible to pose and solve the problem of creating integrated flexible complexes for the automated planning of production and management (IGKAPPU) in industry. These systems, created using computer equipment and robot-equipped complexes, are directed toward implementing a qualitative advance in equipment and technology (not an improvement of existing systems, but a transition to a fundamentally new one). The new systems, moreover, have an integral character and allow the enclosure of the

whole product creation process from the receipt of plan targets through formulation of the intent of the designer to the output of finished products, transforming not only basic production but the auxiliary and maintenance operations as well. These complexes embody an integration of science, technology and production and form the basis of the industrial future.

Effective results do not always occur, however, from the incorporation of computers and robot-equipped systems in management, planning and production. This is explained by the fact that increasing the efficiency and quality of production output with the aid of computer and robot methods and equipment can be obtained only in cases where the production successes achieved are combined with a deep knowledge of the systemic methodology of incorporating and utilizing these systems in industry. Ignoring this methodology can lead to unfounded expenditures of time and material resources and even to the removal of these systems from production.

From the point of view of a systemic approach, the methodology of constructing integrated flexible complexes for planning, production and management should be based on social principles of the development and incorporation of complex cybernetic systems that support their technological, economic and social effect. The following relate to these principles first of all:

--the principle of new tasks and their self-contained nature. The IGKAPPU should include the possibility of a rapid synchronized rebuilding of the planning, production and management systems for new types of products. The self-contained nature signifies that the interconnection of all of the methods of planning, production and management at all stages from technical requirements to product development up to the output of finished products should be ensured;

--the principle of a modular structure and the uninterrupted development of the IGKAPPU. The complex should consist of individual independent modules organized and connected to each other by the management system. The fulfillment of this principle indicates the possibility of the entry of the complex into operation by stages. Following this principle, the incorporation of the IGKAPPU can be improved and accelerated (increasing, modifying and strengthening the contacts between components) simultaneous with its operation;

--the principle of uniformity and standardization. This principle is disseminated throughout the IGKAPPU overall and in the complex planning, production and management components (technical equipment, manufacturing processes and the like); it is reflected in the incorporation of unified documents, methods and modes of operation as well as standards for measuring its quantity and quality. Furthermore, this ensures the effective interaction of various specialists within the framework of the complex, each of whom can write the overall problem and the way of resolving individual tasks in his own manner;

--the principle of informational unity and the full manageability of information flows and material products. The complex requires the realization of a unified information base and the utilization of unified terminology,

languages and methods of obtaining data in the systems, subsystems, program software and components of the complex. Automated management of the flow of information and material products among the work modules should be created in the complex;

--the principle of the man-machine orientation of the IGKAPPU. The complex should be developed as a man-machine system with a careful study of the delineation of functions between man and computer at all stages of planning, production and management. The opportunity should be included in the complex for the gradual transfer of various functions of man to the automated machinery and the retention by man of the decision-making functions;

--the principle of the manageability of IGKAPPU processes and the accessibility of the complex, which should provide the opportunity for man to intervene on-line in the planning, production and management processes at any phase or stage. This makes the complex functionally flexible and capable of being re-aligned and presents the opportunity of having an effect on the progression of the processes of planning, production and management, including the halting and resumption of the operations cycle according to decisions made. It should be emphasized that for the management of the indicated processes, the individual should use a minimum of computer and programming knowledge. The accessibility of the complex substantially expands the circle of people drawn into the execution of planning, production and management and increases the effectiveness of the IGKAPPU overall;

--the principle of the existence of universal optimizing subsystems that should carry out optimization of the decisions adopted in the areas of planning, production and management taking into account their interconnections and mutual limitations. A bank of optimization and retrieval methods criteria is formed in the subsystem, and the possibility for the comprehensive utilization of optimization and retrieval methods criteria in the course of optimizing the decisions being adopted is envisaged as well;

--the principle of the mathematical definability of the tasks being resolved. Problems being solved or arising in the IGKAPPU in the spheres of planning, production and management should admit information to the set of quality-determining tasks being resolved. The knowledge of a mathematical model of the algorithm and the computer program are the its constituent parts, at the basis of the automation of any engineering tasks;

--the principle of invariance. The systems, subsystems and components of the IGKAPPU should be as universal and invariable as possible with regard to the objectives of planning, production and management. Invariable systems, subsystems and components as structural elements allow the execution of defined operations in the receipt, accumulation, transformation and output of information and material products;

--the principle of a comprehensive approach to IGKAPPU creation, consisting of the fact that not one of the IGKAPPU components should be considered apart from the others. The development of systems, subsystems and components should be conducted in a coordinated manner with a regard for their deep internal interconnection.

In developing and incorporating integrated flexible systems components for automated planning, production and management taking into account the principles expounded, it is easy to realize the requirement for the division of the operations into a series of separate tasks (without violating the integrity of the complex) that will be executed by various types of specialists. Realization of the principles will permit a substantial reduction in the cost and labor intensiveness of IGKAPPU creation as well as a decrease in time and an increase in the quality of operations making rational use of labor resources.

In the complex chain uniting science and production, the weakest links remain those that are associated with the practical realization of the achievements of science. It is precisely the scientific and technical societies that are called upon to facilitate the turn of scientific organizations toward the resolution of the most important tasks of production and to develop more broadly the coordination of the efforts of the engineering and technical community with planning, economic and other organizations. Much today depends on coordinating the creative work of the NTO [scientific and technical society] with the rhythm of planning development in the economics of the country and on the correct determination of the field of activity and directions in the resolution of key tasks for the implementation of the economic policies of the state. One of the most important of these areas is the creation of integrated flexible complexes for automated planning, production and management in industry.

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EQUIPMENT RELIABILITY, LIFETIME KEY TO SUCCESSFUL AUTOMATION

Moscow NRT: PROBLEMY I RESHENIYA in Russian No 3 (18), 4-17 Feb 86 p 3

[Article by Prof. B.V. Vasilyev, doctor of technical sciences, and Ya. I. Karker, winner of the Lenin Prize and doctor of technical sciences, "How Are You, Robot? Modern Technology and the Cost of New Equipment Reliability"; passages enclosed in slantlines printed in boldface in original]

> [Text] The losses due to the use of unreliable equipment are estimated to be many times greater than the cost of creating such equipment. With the efforts of domestic industry targeted toward the widespread introduction of flexible automated manufacturing and the development of automated shops and automated plants, the reliability cost of this progressive technology is growing at a rapid rate.
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> In this article Professor B.V. Vasilyev, doctor of technical sciences, and Ya. I. Karker, winner of the Lenin Prize and doctor of technical sciences, examine the problems of increasing reliability as an integral indicator of the quality of the technology developed.

The concept of quality is a broad one. It covers all areas of human activity, from the quality of design concepts to the engineering work needed to transform these into specific products. Reliability is an inseparable part of quality and involves more than just the quality of the product as it leaves the factory. Reliability is the hallmark of any product. It defines how a new piece of equipment functions under various operating conditions encountered beyond the plant gates.

The draft of the "Basic Guidelines for the Economic and Social Development of the USSR" contains the words: "To ensure that all newly developed types of equipment have a 1.5- to 2-fold increase in productivity and reliability over equivalent current products." The problem of reliability is especially critical when, in accordance with the Basic Guidelines draft, there will be: "...widespread introduction of flexible, retoolable manufacturing and automated design systems, automatic lines, automatic machines and equipment containing integral microprocessor-based hardware, NC multi-operation machine tools, as well as robotic, rotary and rotary-conveyor complexes."

The appearance of flexible automated plants with a large number of robots and computers brings us closer to the introduction of unmanned manufacturing. Productivity and the level of equipment interchangeability increase sharply in these systems. At the same time there is a sharp rise in the cost of any failure of individual devices, computers and software modules. If effective steps are not taken to increase hardware and software reliability in flexible manufacturing systems we may not achieve the planned level of increase in labor productivity and the planned doubling of the nation's production potential.

The glitter of individual flexible manufacturing modules (GPM), flexible manufacturing systems (GPS), robots and new NC machine tools can obscure the most important point: increasing their operational reliability within the flexible manufacturing equipment system and increasing the reliability of computer software used in this system. The complexity of the problem arises from the fact that it cannot be completely solved by the efforts of isolated enterprises, scientific facilities, institutes of higher learning or even through the work of a single branch of industry. The efforts of scientists and specialists must be concentrated on a nationwide scale to increase reliability.

The creation of an Interbranch Scientific Technical Complex on the problem of machine tool product reliability was an important step in this direction. Even this group cannot, however, cover the entire problem. The problems of a massive increase in reliability and in computer hardware and software survivability* are too large to be solved by this group alone. Enterprises from all branches of the national economy must, without exception, be focussed on this problem and the scientific potential of the nation's institutes of higher learning must also be brought to bear. We must always bear in mind that low equipment reliability shows up in operation by disrupting the end user's production program. This means that everyone without exception must become involved in solving this shortcoming.

It is known that the costs of increasing reliability can be recovered quickly. According to data from abroad, $180 of revenue result from every dollar invested in increasing reliability. Furthermore, unreliable equipment -- such as a computer for example -- is three times more expensive due to the cost of spare parts, operation and repair.

Unsatisfactory software reliability also leads to high outlays. According to research data from a number of foreign firms, the cost of a single error is $140 when discovered during the specification preparation stage, $1000 during the coding stage, $7000 during the system debugging stage and from $14,000 to $140,000 during the installation stage. Without software reliability testing the error could continue into the operational stage with

*Survivability is a system's ability to remain functional under extreme conditions not envisioned in the TU [Technical Standards]. Examples include sharp changes in humidity and temperature, high levels of dust, etc.

even greater losses being incurred. Furthermore, in industry an error can lead to enormous amounts of wastage or even the shutdown of a flexible manufacturing shop. This makes it apparent that special software testing must be carried out to ensure reliability.

In this country there are two objective conditions for the solution of this critical problem. Soviet scientists specializing in the theory of reliability are world leaders in the field. The school of our USSR Academy of Science Academician B. V. Gnedenko is widely known. USSR Academy of Sciences corresponding member B.S. Sotskov has laid the foundation of physical reliability which has quickly grown into an important theoretical and practical field.

Useful experience has also been accumulated in domestic industry. The causes of possible failures are uncovered and degradation processes leading to failure are studied during the design process. This permits a more precise evaluation of product and production equipment reliability indicators and timely intervention to increase these same indicators. Unfortunately, this is not true everywhere. For various reasons the developer is experiencing difficulties in the investigation of failure causes and degradation models which lead to failures and disruption of the engineering process.

There are reliability sections working in industry today, but in most cases these are unsatisfactory groups staffed by poorly qualified personnel who do not have a sufficient understanding of the bases of reliability, failure models and degradation processes. These are not prestigious groups. They are not equipped with modern investigative tools since the evaluation methods in use today are often primitive and do not require the study of failure models. Moreover, no managers will adopt a production control method which sorts out products which meet current output standards but are potentially unreliable and thus results in above-standard wastage levels.

Practice shows that this method is not even used for input monitoring at interfacing enterprises (due to fears of disrupting product output). This situation even prevails in the development of strict overall testing, including the testing of extreme environmental condition effects on the item. No judgement on the survivability of a future system can be made without this type of testing. All of this delays any extensive solution of the problems.

In our opinion, the entire responsibility for developing system and production equipment failure models must be placed in the hands of the designers of materials, instrumentation components, machines and systems, as well as in the hands of production engineers. A description of the failure models developed must become a mandatory document in the unified systems for design and engineering documentation (YeSKD and YeSTD). These types of documents should be the basis for evaluating reliability and developing an overall method for testing reliability, test facilities and diagnostic instrumentation. Similarly, software documentation must describe failure sources and information on the development of a method for testing software reliability.

The automated shop of the future is an integral "living" entity which must work with maximum productivity and be reliable and survivable. Here we run into a problem when no understanding of the failure of this flexible complex can be given. The reliability of this type of system can be equated to the health of a human being. When individual devices fail the complex is not stopped, it just operates at lower productivity until the causes of of the failure are corrected. The design of flexible systems requires an understanding of the theory of their reliability and efficiency. This theory has been developed but has not yet been widely introduced into practical applications. Questions of operating these engineering complexes on the basis of forecastable conditions are especially important.

We know that the level of control and measurement instrumentation determines a unit's scientific and production potential. Without important advances in this area it will be extremely difficult to increase reliability. For this reason we believe that a unified all-union targeted program should be initiated to create a full line of measurement instrumentation for flexible manufacturing.

In our opinion a new specialty -- "Reliability and Survivability of Equipment and Software (organized by branch)" -- (requiring master's and doctoral dissertations) should be introduced in higher education curricula in order to advance the theory and practice of reliability work.

Considering the critical role of equipment and software reliability and survivability in the acceleration of scientific and technical progress and successful implementation of the plans set forth (a doubling of the nation's production capacity by the year 2000 and a 2.3- to 2.5-fold increase in labor productivity) we feel that corresponding amendments should be made to the draft of the new edition of the "CPSU Program" and the draft of the "Basic Guidelines for the Economic and Social Development of the USSR."

1. The following paragraph should be included after the paragraph: "Of primary importance is..." in Section II of the "CPSU Program" draft: /"The automation of manufacturing, the change to flexible robotic manufacturing and the automation of scientific research on the basis of widespread use of computer complexes, microprocessors and artificial intelligence require a massive increase in the reliability and survivability of computer hardware and software as a decisive condition for accelerating scientific and technical progress."/

2. The following paragraph should be included after the paragraph: /"Significantly speed the development of machine construction..." in Section II of the "Basic Guidelines": "Speed the solution of the overall problem of a massive increase in computer hardware and software reliability and survivability by developing the theory and practice of producing physico-chemical failure models, models of degradation processes in materials, components and devices, and models of production process breakdowns which will allow long-term individual forecasting of failures and production process breakdowns. Place all responsibility for the creation of these models on the designers of materials, components, devices and systems, as well as on production engineers. Concentrate the efforts of the nation's scientists and

experts in the field of reliability on the solution of this critical problem on which the successful completion of the plans set forth depends."/

3. The following new paragraph is proposed to follow the paragraph: "Introduce flexible manufacturing on a wide scale..." in Section V of the "Basic Guidelines": /"Change to automated operation of devices and systems in flexible manufacturing facilities with the use of status forecasting and optimized material, component and device stockpiling."/

12746
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METHOD FOR CUTTING NUMBER OF RESERVE MACHINE TOOLS EXPLAINED

Moscow MATERIALNO-TEKHNICHESKOYE SNABZHENIYE in Russian No 5, May 86 pp 24-27

[Article by A. Ilyshev, Assistant Professor of Kharkov State University imeni A. M. Gorkiy, and N. Ilysheva, Assistant Professor of the Kharkov Engineering-Economics Institute: "The Distribution of Machinebuilding Equipment by Actual Need"]

[Text] The successful solution of the large-scale tasks for developing machinebuilding that the 27th CPSU Congress set should be provided for primarily by better utilization of the potential that exists in the branch, accelerated updating of the equipment pool, and an increase of its workload. Workers of USSR Gossnab organs have been called upon to make a definite contribution to execution of the decisions adopted for speeding up development of the machinebuilding complex.

The fact is that machinebuilding-enterprise orders for new equipment often are overstated and do not always consider their actual potential for providing a workload for it. A method for differentiated distribution can, in our view, be applied in order to improve prevailing distribution practice. All machinebuilding enterprises of the various branches and regions are divided into three groups--those that have a low shiftwork factor for installed equipment (less than 1.3), a moderate factor (1.3-1.5) and a comparatively high one (above 1.5). Data on shiftwork-factor values are contained in the quarterly reporting form 1-TP, which goes to the statistical organs.

The grouping of enterprises by factor allows the satisfaction of their orders for equipment to be approached differentially. Thus the needs of first-category enterprises can be satisfied just by 20-25 percent, enabling the replacement of obsolete and worn equipment that falls into disuse during the plan period. It is desirable to satisfy orders of the second group by 40-50 percent, the third by 70-80 percent or more. The differentiated distribution method will enable USSR Gossnab organs to effect in principle and purposefully a rise in the equipment workload, since the share of equipment for those enterprises that provide for better utilization of this form of resource will constantly increase.

At the same time, this approach does not solve the problem as a whole. First, the overstating of shiftwork values on the enterprises' reporting form 1-TP, which can engender mistakes in distributing equipment, occurs often. Second,

enterprises that use equipment well can assign the new equipment not only to bottlenecks but also to less critical points (in the latter case it clearly will be underused). Third, the bounds of the low, medium and high levels of equipment workloads are somewhat arbitrary in nature and are not substantiated by progressive norms. It should be emphasized that during this five-year plan, for the first time, branch norms for the annual work potential of the equipment and the shiftwork factor will be affirmed.

It would seem that, in order to apply them successfully, first of all a standard, differentiated by branch, for reserve equipment and for equipment for which idle time for whole days is similarly regularized, should be developed. The use of this standard, combined with determination of the amount of operating equipment needed to carry out the approved production program, will enable an overall standard amount of equipment to be computed for each enterprise of the branch and the existence of above-standard amounts thereof to be revealed.

The total amount for the standard for reserve equipment is made up of three components: equipment laid up in storage, a special operating reserve, and a reserve for mastering the production of new output. There are no standard directives of any kind for figuring the amount of equipment laid up in storage. Actually, it is governed by the decision of higher management organs. Because of this, the standard amount of equipment laid up in storage must be rejected when computing the first component of the overall amount of the reserve. Thus, according to the data from a survey of five Kharkov machinebuilding enterprises, the share of the latter in installed equipment actually comes to about 1.8 percent.

The special operating reserve comprises standby machine tools, the necessity for which arises as a result of various external and internal factors that are both dependent upon and independent of the enterprise. Many of them cannot be recognized as objective and must be reflected in the standard amount of the operating reserve. For example, it is not desirable to have equipment on hand that is not at all necessary for fulfilling the approved production program--as enterprises sometimes do--because it can be needed for hypothetical structural changes in the range of products produced. Such a reserve can be characterized only as a reserve for mismanagement.

The attitude should be similar toward wishes to have a standby machine tool in reserve for practically each unit of operating equipment in case of breakdown of the basic one. Accidents caused by the poor operating condition of the equipment pool must not be accepted in computing the standard value for the operational reserve. For they are explained by low equipment-operating sophistication and low quality of repairs made by the in-house method.

The standard value for the special operational reserve can be found primarily by processing the data on current reporting of repairs, supplemented by the results of the experts' inquiries to a large number of experienced specialists engaged in the operation and repair of the various models of equipment. The average breakdown frequency through the manufacturing enterprises' fault, their duration, and the number of standby machine tools needed to compensate for the idle time that ensues are determined by a similar method.

For example, in one of the mechanical departments of the Kharkov Tractor Plant imeni S. Ordzhonikidze, 22 of 200 units of equipment failed last year because of accidents resulting from manufacturing defects. The time taken to eliminate this idle time varied from 10 to 132 workdays (an average of 41 days). Given 254 workdays per year and an absence of cases where machine tools of the same kind fail simultaneously, the standby machine-tool reserve should be four units, according to the calculations.

The standard amount of the special-equipment reserve is calculated more precisely by methods of the theory of large-scale service, which enable optimal values for the reserve to be set by minimizing total losses from the upkeep of the machine-tool standby and from idle time of the basic equipment because of accidents. The experts' survey performed at five Kharkov machinebuilding enterprises enable a determination that the special operational reserve for them should be 1.6-1.9 percent of the total pool of installed equipment.

The standard reserve of equipment for mastering a new product, that is, the third component of total reserves, is calculated in two stages. First, the equipment necessary for producing the new output should be determined for each of the next 8-10 years. It is found by multiplying the quantity of equipment required for fulfilling the entire production program (calculated on the basis of the specific machine-tool intensiveness for the product already mastered) by the share of the new output, by the complexity factor (that is, by the ratio of average ranking coefficients for the new and the previously mastered output), and by the coefficient for mastery, which reflects the amount of equipment idle time and the reduction in its productivity while manufacturing the new product.

In further calculations performed at the second stage, the new product is considered an integral component of the enterprise's entire output, which should not be set off against the already mastered output. Some portion of the enterprise's operating equipment is constantly engaged in manufacturing the new output.

Thus, the standard value of the reserve equipment for mastering can be characterized as an additional requirement for the years of an especially rapid conversion to new output. In accordance with what has been set forth, it is determined as the average for the years of intense mastery of the additional requirement. The calculations carried out for the five Kharkov machinebuilding enterprises indicated that the standard value of the reserve equipment for mastering production of new output is 1.1-3.7 percent of the total pool of installed equipment.

The necessity for singling out this component of the overall standard equipment reserve could until recently have seemed debatable. For underutilization of the basic equipment pool in machinebuilding reaches high values everywhere, and it would seem, it would permit, when necessary, the manufacture of additional new output. However, these current reserves prove to be not completely suitable for performing the complicated and important work of preparing for production of the new output (incompleteness, latent unsuitability, and so on). In any case, they cannot serve as a reliable basis for speeding up introduction of the achievements of scientific and technical progress at each enterprise.

A summing up of the three components of the standard value for reserve equipment enabled absolute values and the share of the total reserve to be obtained. The latter were 4.6-6.5 percent of the equipment pool for the five machinebuilding enterprises surveyed (an average of 5.5 percent).

Reserve equipment usually is idle for whole days. And only special circumstances--accidental breakdown of the basic equipment because of manufacturing-enterprise factors, and intensification of the process of mastering the new output--leads to the need to use the reserve equipment temporarily. During the normal course of the production process, the time spent in reserve engenders regularized idle time for whole days for a strictly defined portion of the overall equipment pool.

However, regularized whole-day idle time now and then arises with working equipment that is not in reserve. For example, each unit of operating equipment must undergo planned preventive maintenance. Moreover, there are social causes for regularized whole-day idle time (because of the expenditure of worker and machine-tool time on the fulfillment of state obligations called for by law).

The stay of some unit of operating equipment in regularized whole-day idle time because of these two factors is equivalent to the constant inactivity of a portion of the overall equipment pool. The standard value for whole-day idle time as a result of equipment time spent in planned maintenance is figured in accordance with the unified system for the planned preventive maintenance of equipment that is operating in the national economy. The total duration of such idle time depends upon the type of production facility, the technological structure of the equipment pool, and the operating practice. Computations made for the five Kharkov enterprises surveyed showed that whole-day idle time as a result of equipment being in planned-preventive maintenance was 3.8-5.6 percent of the available time.

So the total amount of regularized whole-day downtime for all the causes described above varied at the various enterprises within the 9.1-12.2 percent range (an average of 10.6 percent). The latter means that the average value for the standard utilization factor of the installed equipment pool was 0.894, while the standard shiftwork factor was 1.788, or twice as much (two-shift operation has been established practically everywhere for machinebuilding). The overall standard for nonoperating equipment as a whole was 10.6 percent for the enterprises surveyed, including the standard for reserve equipment of 5.5 percent.

A comparison of the amount of actually inactive equipment with the standard value for it computed above for the five enterprises is of definite interest. An analysis was made of the mechanical department of the Kharkov Bicycle Plant imeni G. I. Petrovskiy. The excess of the standard in percents for the installed equipment was: 1.2 for the special operating reserve, 1.6 for the reserve for mastering new output. Four percent of the equipment was involved in downtime for nonregularized causes (as a result of malfunctions and unplanned repair), and also more than 3 percent for other organizational and technical causes and because of labor discipline violations. On the whole, above-standard nonoperating equipment consisted of more than 10 percent, or 26 units.

Seven units of the equipment that were included in the above-standard amount of the special operating reserve and the reserve for mastering new output were subject to first-priority withdrawal and redistribution. The question of the withdrawal and redistribution of the remaining 19 units of equipment that were not operating for nonregularized causes should be solved gradually, as measures for improving equipment-repair quality, for observing the proper operating procedures, for improving the supply of workplaces with all the necessary supply items and services, and for strengthening labor discipline are developed and implemented.

Consequently, the development of a standard for reserve equipment will enable the discovery of surpluses at each enterprise and involvement of a substantial portion of the now inactive equipment in economic circulation. This standard can also be a useful auxiliary tool for supply and equipment organs when they review the orders of the machinebuilding branches for new equipment.

An important task is improvement of the procedure for redistributing among enterprises equipment that has been released in connection with the certification of workplaces. It would appear that, in so doing, a rational combining of centralized planned distribution should be combined with further expansion of the enterprise's self-sufficiency. Experience in this exists.

Thus, Department No 5 of the Kharkov Tractor Plant imeni S. Ordzhonikidze freed 80 metal-cutting machine tools through workplace certification. Half of this equipment was sent to the enterprise's four other departments, 20 to other enterprises in the republic, and, finally, 20 worn machine tools were written off as scrap. The released equipment was distributed with the authorization of Minselkhozmash [Ministry of Tractor and Agriculture Machine Building], while distribution outside the plant was made with the collaboration of USSR Gossnab organs.

It must be noted, however, that each machinebuilding ministry strives to contain within its branch the process of redistributing equipment that is released during workplace certification, but doing so does not always meet overall interests. From our point of view, USSR Gossnab regional organs should take part more actively in organizing interbranch redistribution of serviceable equipment released at enterprises in their areas.

Measures still are not always being taken in timely fashion to eliminate (or reduce) above-standard reserves of uninstalled equipment. Lengthy assembly time, delays with the turnover of equipment already installed, and the existence of surplus and unsuitable equipment that is subject to writeoff--all these lead to the freezing of substantial reserves.

Thus, 2 or 3 years ago the above-standard reserves of uninstalled equipment at the Kharkov Tractor Plant imeni S. Ordzhonikidze were more than a third of the amount of annual shipments of new equipment to this enterprise. After the correct criticism to which the plant was constantly subjected, the enterprise collective made efforts to correct the existing situation. At present there are no above-standard reserves of uninstalled equipment at the Kharkov Tractor Plant.

The example cited and other examples indicate that there are no insuperable impediments to reducing uninstalled equipment. A strengthening of discipline and order and a high stage of organization in all elements of the national economy will enable the utilization of equipment that arrives at or is present at enterprises to be greatly improved. Solution of the problems posed will respond directly to the CPSU's policy of speeding up the pace of social and economic development and of increasing production effectiveness by bringing into action intensive factors for growth and for making better use of the production potential that has been created.

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INDUSTRY PLANNING AND ECONOMICS

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INDUSTRY PROGRESS, PROBLEMS ASSESSED

Moscow MASHINOSTROITEL in Russian No 6, Jun 86 pp 1-3

[Article by A.Ya. Rybakov, chairman, central committee, Trade Union of Machine Building and Instrument Making Workers; member, CPSU Central Committee; Hero of Socialist Labor: "Recent Developments and Extent of Existing Problems"]

[Text] The entire life of our society is governed today by the course outlined by the 27th CPSU Congress. The key to understanding existing problems and to developing ways and methods of solving them became the political report delivered at the congress by the general secretary of our party, M.S. Gorbachev.

The highest goal of the party's economic strategy has been and remains the steadfast raising of the material and cultural level of the life of our people. The objectives of the current five-year plan period are also governed by this: increasing the pace and the efficiency of the development of the economy based on the speeding of scientific and technical progress, the retooling and redesigning of production, the intensive utilization of developed production potential, and improvement of the system of management and the economic machinery. In this connection the country's national economy is demanding of machine builders and instrument makers most energetic action, since implementation of the program developed by the party for the modernization of machine building rests principally on their shoulders. Here it must not be forgotten that the plans specified for machine building and instrument making for the forthcoming period were dictated by the needs of the country's national economy and are based on the capabilities of the already existing scientific and production base. They are realistic, and doing everything for their fulfillment is the principal goal of trade union committees and business managers and of each worker.

The results of the present year have shown that the plan quotas for the first quarter were fulfilled in terms of the principal technical and economic indicators by all ministries, and the pace of the growth in production volume and labor productivity is considerably faster than last year's.

Along the road of moving forward it is necessary to eliminate reasons for negative effects which are hindering collectives, and for each worker to

implement in practice his right of ownership given to him by the socialist system and the legislation on labor collectives. Today each one must by his personal example affirm an innovative, creative approach to the job entrusted to him and in every possible way support enthusiasm and selflessness in labor in collectives. Only in this case will what has been planned not remain just wishes but be transformed into reality; only in this case will the "human factor" begin to be heard loud and clear.

The socialist competition has been called upon to arouse the labor and social activity of the masses and their energy and initiative. Today it must be aimed primarily at speeding scientific and technical progress, the improvement of quality indicators, economizing and thrift, and at the achievement of the planned limits in each collective and at each work place. Able to serve as an example of lively initiative-taking work in organizing the competition and in the creation in collectives of an atmosphere of interest and healthy competition aimed at improving the total end results are the collectives of the Sumy Elektron, Aktyubrentgen and Minsk Machine Tool Building Plant imeni the October Revolution production associations and the Perovskiy Commercial Machine Building, the Odessa Food Industry Machine Building and the Vilnius Drill plants. At the Lenpoligrafmash plant the basis of organization of the socialist competition has been the mastery of new equipment and advanced technology, streamlining and inventiveness, economizing on raw materials and materials, and the initiative of workers in reviewing the norms. The winner here has become not he who makes more parts, but he who has made a real contribution to reducing labor intensiveness for the section and shop. As a result, objectivity in job evaluation and the prestige of the labor rivalry winner have been increased.

Trade union committees in conjunction with the administration and scientific and engineering community must reach the situation whereby all the competitors' efforts are concentrated on the novelty of the solutions employed, raising the technical level of work done, shortening the time taken to do it, increasing the number of inventions and their utilization in work, and the speediest introduction of all the best into the national economy.

These directions must form the basis of the personal creative plans of scientific and engineering and technical personnel, since the leading role and responsibility for the development of high-efficiency machines, instruments and equipment and advanced production processes belongs to the collectives of scientific research, planning and design organizations.

To place into service everything that is new and progressive is one more fruitful step along the road. Interesting and helpful know-how must be brought to each collective and, what is most important, it must be shown how it is used and what real return it will bring in improving quality indicators, labor productivity, conservation of resources and improvement of social conditions.

The speeding of scientific and technical progress is impossible today without high-quality products. The collectives of science sectors have been called on to become the champions of a radical improvement in product quality.

Indicators of technical level, reliability, and metal and power consumption, i.e., everything that unites in itself the concept of the quality of machine tools, machines, instruments and equipment produced, have been entrusted here. At the same time, according to the data of the USSR Gosstandart [State Committee for Standards], last year alone sanctions were applied by inspection agencies against 80 organizations of machine building industries which develop design and technical documentation. Besides, social influence on the improvement of quality indicators is clearly insufficient. It is exactly this which explains the fact that according to last year's results in machine building and instrument making industries every fifth enterprise did not fulfill its plan for the output of products of the highest quality category, and about 600 products were without the honorable pentagon [emblem of quality].

Trade union organizations must considerably step up their activities in cultivating in each worker, be he an ordinary worker or engineering and technical personnel, a sense of responsibility and professional pride in producing products of a high technical level and quality, and in the honor of the plant's trademark, and must achieve the fact that each member of a collective works conscientiously for the common good, strictly observes discipline, evidences initiative, and looks after the interests of the State as after his own. The conditions for this have been created by the large-scale economic experiment, whereby the economic and financial well-being of collectives is more closely tied in with the end results of their activities, and with the utilization of cost-accounting principles for the entire production chain--from the brigade to the enterprise and association.

During the years of the last five-year plan period brigade forms became the principal ones in the organization and provision of incentives for labor; more than 70 percent of machine building and instrument making workers were united into them. There are also among them continuous and integrated forms, which work in a single detail and distribute earnings by taking KTU [Labor Participation Coefficient] into account. However, there are clearly insufficient cost-accounting brigades which increase to a maximum the sense of responsibility and interest of workers in the end results, and which open up freedom for initiative and enterprise. Such brigades constitute 39.4 percent of the total number of brigades in Minpribor [Ministry of Instrument Making, Automation Equipment and Control Systems], 21 percent in Minstankoprom [Ministry of the Machine Tool Building and Tool Industry], and 15.4 percent in Minlegpishchemash [Ministry of Machine Building for Light Industry, the Food Industry and Household Appliances].

Employing in practice the rights granted by the legislation on labor collectives, brigades have been called upon to have their say also in affirming the principle of social justice. It is precisely in them, primarily, that it is important to achieve genuine payment according to the work done. Otherwise the brigade form of organization and payment for work does not produce the anticipated result in a growth in labor productivity, and collectives formed fall apart. This occurred, for example, with the brigade of metal workers and assemblers at the Temp NPO [Scientific Production Association] pilot plant, where over the course of a prolonged period the administration and trade union committee could not organize in the proper manner norm setting

and payment for the work of workers. As a result, an unfavorable morale and psychological climate was created in the collective, production figures dropped, and the brigade fell apart. The development of the brigade form is being held back at the Bronnitsy Jewelry Plant by the lack of preparation of production and economic services. The managers and trade union committee of the Dnepropetrovsk production engineering enterprise of the Tekhremkuzmash PTO [Production Engineering Association], who in a number of instances covered production expenses from the material incentives fund, committed gross violations of the existing labor legislation in the payment of wages.

All the ideological and educational work of trade union organizations should serve the purpose of ensuring a high degree of organization, order and discipline in all sections and in all units without exception. Here it is necessary to place at the head of the list concrete assistance to each worker in defining his contribution to the process of picking up speed, overcoming shortcomings and revealing unutilized potential, and the cultivation in each person, whatever work place he labors at and whatever position he holds, of a high sense of duty and responsibility for the task entrusted to him and for the results of his labor.

Taking into account the fact that it is a very complicated matter to overcome sluggish thinking, it is necessary to achieve a decisive turning point in existing habits and traditions. The adherence of some trade union organizations to obsolete forms and methods of working which are inconsistent with the spirit of the times, the substitution of this spirit with far-fetched campaigns and "quick fix" measures, a retreat from real life and a gap between word and deed are considerably reducing the effectiveness of the communist education of workers. It is was emphasized at the party congress that "the future will be determined to a great extent by what kind of youth we are educating today." Therefore, questions relating to the education of youth and creating for it the conditions for fruitful labor, training, daily life and leisure require the constant concern of trade union committees.

Fundamental changes in the social sphere are impossible without profound transformations in the content of work aimed at fulfillment of the quotas of integrated plans for improving working conditions and labor safety procedures and sanitation and health measures, at the creation of safe conditions on the basis of work safety standards, the general introduction of a work safety control system, and the extensive utilization of advanded know-how. Unfortunately today it is not possible to name one enterprise at which the quotas of the integrated plans and labor safety agreements have been fulfilled to the full extent. And here the story is not the lack of means and capabilities, but an indifferent, irresponsible attitude of officials toward protection of the health and life of people, and the lack of principles of trade union committees. Take at least the Rostov Elektrobytmash PO [Production Association]. In many departments of this association working conditions do not conform to the current standards, the plenum-exhaust ventilation is operating unsatisfactorily, and there is a lot of manual labor; the planned measures for labor safety procedures are not being implemented. There is a

similar situation at the Tallinn Prompribor PO. Making up for losses caused by unsatisfactory working conditions and work organization and unproductive losses of work time is compensated here by overtime. Besides, funds allotted for the reconstruction of individual enterprises are not being utilized fully; often they are channeled not toward the updating of existing production processes but toward the construction of new buildings and the opening of all kinds of branches.

Problems relating to work safety procedures and reducing temporary disability should be solved in an integrated manner. Radical restructuring is necessary in work relating to protecting the health of workers, imparting this work with a systematic nature, and mobilizing the entire available arsenal of forms and methods making it possible to strengthen the health of workers, and to reduce temporary disability considerably. Only daily, concrete, purposeful and the combined work of business managers, trade union committees of enterprises and medical personnel can yield positive results in the job of prevention and reducing illness rates and strengthening the health of workers.

The organization of personal services for workers directly at the production site requires unflagging concern. Experience has demonstrated that a well furnished job site is conducive to a great extent to holding onto personnel and reducing losses of work time. At those enterprises where there are no personal services facilities, the number of leaves associated with obtaining personal services is 20- to 25-percent higher. Objectives of social importance include ones such as increasing the extent of housing construction and reconstructing the housing inventory, the construction of cooperative and individual housing, the erection of youth complexes, the construction of workers' dormitories and plant dining halls, raising the level of services to workers and office personnel in them, and an increase in the number of preschool facilities.

Recent developments and the extent and complexity of existing problems require of all trade union organizations persistent efforts, purposefulness, efficiency and selflessness. An issue of first-level importance is to ensure the radical restructuring of trade union work and to establish firmly a general atmosphere of creativity, adherence to principle and exactingness.

"The style which is needed now," it was noted in the political report to the congress, "is concreteness, efficiency, consistency, unity of word and deed, the choice of the most efficient methods and means, careful consideration of peoples' opinions, and the skillful coordination of actions." The goals which the party has set for our people are enormous and there is no doubt that machine builders and instrument makers will make their contribution to the task of increasing the might of our homeland.

8831
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DISCUSSION ON MACHINE-BUILDING STRATEGIES

New Types of Production Equipment

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 8 (23), Apr-May 86 pp 4-5

[Interview with USSR Academy of Sciences Vice President Academician Konstantin Vasilyevich Frolov by NTR: PROBLEMY I RESHENIYA correspondent A. Lepikhov under the rubric "A Problem Close-Up": "Machine Building: A Strategy for Development"]

[Text] Machine building is the foundation of scientific and technical progress in all sectors of the national economy. In upcoming years, we will have to carry out a sharp raising of the level of production output and ensure the creation and assimilation of the production of new-generation equipment that permits an increase of many times in labor productivity and substantially reduces material expenditures in this sphere; the material, scientific and technical base of machine-building production should be substantially reinforced as well. These tasks cannot be resolved without the closest interaction of the academic research institutions with the sector NIIs [scientific research institutes], KBs [design bureaus], scientific production associations and the major enterprises and without conducting, on the one hand, basic research oriented toward the future, and on the other hand, without developing a mechanism for "echoing" academic science in the topical problems of the machine-building complex. At the request of our correspondent, USSR Academy of Sciences Vice President Academician K. V. Frolov discusses problems in Soviet machine building and the role of the Academy of Sciences in their resolution.

Research Echelon of Machine-Building Production

[Question] Konstantin Vasilyevich! The machine-building complex of our country is truly enormous. Therefore, let's limit the theme of our discussion just to those problems of machine building that are resolved at the USSR Academy of Sciences. And, if you agree, I would like to pose the first question: what tasks in the development of machine building stand before basic science today?

[Answer] Today the USSR Academy of Sciences, in conjunction with the academies of science of the union republics and the sectors of industry, is working on fulfilling the Program of Fundamental Research for 1986-90. Its fundamental areas are the automation of machine building, an increase in the reliability and service life of machinery and equipment output, the creation of new structural materials, the conducting of a technical and economic analysis of problems in the machine-building complex and the development of collaboration with the CEMA member nations. Work has been begun at the Machinery Science Institute of the USSR Academy of Sciences, in conjunction with the International Center for Scientific and Technical Information, on providing information support for the "Comprehensive Automation" priority area of the Comprehensive Program of Scientific and Technical Progress of the CEMA Member Nations. The purpose of this work is to encompass, with the aid of databases and data banks, the worldwide flow of documentary and factual information in the sphere of basic and applied problems in machine building. (Footnote) (see NTR: PROBLEMY I RESHENIYA No 4, 1986)

Naturally, the academic-science institutions are concentrating their efforts chiefly on the creation of the theoretical bases of fundamentally new types of highly productive equipment and prospective technologies and on the widespread application of automated planning and computing systems for the design of machinery and structures, the control of manufacturing processes and the comprehensive automation of the machine-building industry.

A new Division of Problems in Machine Building, Mechanics and Process Control has been created at the USSR Academy of Sciences for the purpose of developing scientific potential and the experimental, design-testing and productive base, as well as concentrating existing resources for the comprehensive resolution of topical problems of machine building. The major academic institutes are included in it.

Unusual Associations

On the initiative of the USSR Academy of Sciences and the GKNT [State Committee of the USSR Council of Ministers for Science and Technology], a number of interbranch scientific technical complexes (MNTK), including Machinery Reliability and Robotics, have been formed.

Within the framework of the Machinery Reliability MNTK, which I have been entrusted with heading up, work has begun on increasing the reliability of all machine-building products. The principal approach to resolving this most important problem is clear--the reliability of new equipment should be incorporated right at the stage the development of technical documentation and the production processes of the innovation.

The task of the Robotics MNTK is to create highly efficient machinery, apparatus and manufacturing processes on qualitatively new principles along with the development and broad-scale incorporation and support of the highly efficient operation of robot transporting systems. Another area of its work is the improvement of diagnostic methods for robot-equipment systems in machine-tool building and their incorporation into the practice of our production associations.

The Institute of Machinery Science imeni A. A. Blagonravov--the leading academic organization in the sphere of problems of machine building--has recently been appreciably strengthened. Branches of the Institute of Machinery Science have been organized in Gorkiy, Sverdlovsk, Leningrad and Saratov; the essential preparatory work for the creation of similar branches in Kuybyshev and Volgograd is being conducted.

Provincial Centers

[Question] Right away there are two questions: what facilitated the selection of namely these cities, and why didn't you proceed along the usual route--the creation of independent NIIs--rather than make the new research collectives branches of the Institute of Machinery Science of the USSR Academy of Sciences?

[Answer] I'll answer the second question first. We already spoke of this at the 27th CPSU Congress, and I will repeat it again nonetheless. The role of the technical sciences was once clearly underestimated at the academy. The Division of Technical Sciences that had existed earlier was disbanded, and a number of technical-type institutes were removed from the complement of the Academy of Sciences. In previous years, several of them were repeatedly shuffled from one department to another, lost their fundamental nature, ceased to be occupied with promising research and lost creative personnel.

By creating not independent NIIs, but instead branches of the Institute of Machinery Science with a whole series of scientific schools, noteworthy traditions and a developed experimental base, we are hoping that all of this will be perceived by the new research collectives and will allow them to move more quickly to a modern level of research and obtain their first results.

Now the answer to your first question. Take, by way of example, the city of Gorkiy. It is one of the major industrial and scientific centers of the country.

Motor vehicles and ships are made, aircraft and machine tools are produced and modern measuring instruments and improved power equipment are created in Gorkiy Oblast. The products of the Volga-Vyatka industrial region are shipped to 80 countries. And at the same time, there is not a single specialized NII here that would be occupied with the resolution of intersectorial problems that arise in the creation of modern equipment and new processes. The results of such an "alienation" between machine-building practice and basic research and development are well known--many industrial products have excessive materials consumption, are poorly competitive on the world market and still insufficiently incorporate fundamentally new technical solutions.

It is perfectly natural that after the organization of the branch of the Institute of Machinery Science, basic research will be developed in Gorkiy with the purpose of raising the quality and reliability of machinery based on the utilization of such new technologies as plasma, laser and powder ones. They will also begin to develop design methods for the cyclical strength and wear resistance of structural elements, create automated planning systems and

improve methods of reducing the materials consumption of machine-building products through the optimal application of namely those modern technologies of which I was speaking.

Such a broad spectrum of research requires that specialists be working at this branch in the spheres of mechanics and applied mathematics, physics and the theory of experiment planning along with savants of computer technology and optimization problems. The number of workers will be increased basically with young graduates of higher educational institutions, including, naturally, the Gorkiy University imeni N. I. Lobachevskiy and the Gorkiy Polytechnical Institute imeni A. A. Zhdanov.

The Sverdlovsk and Saratov branches of the Institute of Machinery Science will be the largest of those created.

Its foundation in Sverdlovsk was the department of integrated machine-building problems created earlier within the framework of the Metallurgical Institute of the USSR Academy of Science's Urals Science Center. There is already substantial work in progress here today on the creation of a foundry rolling complex for the production of hot-rolled steel strips directly from the molten metal, and research is being conducted on creating a continuous process of acid-free cleaning of steel from scales. What will be produced by the fulfillment of only a portion of this work? Some 850-950 kilograms of finished rolled metal will be obtained from each ton of molten metal (instead of the 650-750 kilograms today); in the production of 100,000 tons of parts blanks, approximately 70,000 tons of metal will be conserved and about 8,000 workers will be freed up; and, problems of preserving the environment in the area of metallurgical and machine-building plants will be resolved.

I might add that the results of the Urals scientists are quite innovative and are directed toward developing systems of machinery that, in their technical and economic parameters, surpass the best analogous systems both in our country and abroad.

In Saratov, where nationally well-known scientific schools of machine building have been set up, electronic equipment and instrument building have been greatly developed. The resolution of the problems of automation in machine building is becoming a fundamental area of activity for the branch of the Institute of Machinery Science. The base of this automation is new technology, computers, robot systems and microprocessor equipment and SAPR [computer-aided design] systems at design bureaus and industrial enterprises. The incorporation of the developments of the scientists will be considerably eased thanks to the fact that experimental-design bureaus and experimental plants will also be included in the complement of the branch. Here, as at our other branches as well, the work need not start from scratch. There are already many interesting developments at the sectorial NIIs and KBs of Saratov. I have in mind, for example, the robotized lathe module that is controllable by microprocessor. Measuring equipment created using lasers, noiseless drives and so-called aerostatic supports are employed. The Saratov scientists and engineers have developed a transport apparatus with artificial intelligence, created a number of easily reset robotized complexes for assembly processes and developed and incorporated original SAPR systems and

automated manufacturing-process control systems. An entire school of the physics of automation-element failures is also being successfully developed here.

And finally, the last of the already existing branches of the Institute of Machinery Science--the Leningrad one.

The creation of the Leningrad Branch allows a turning of basic science toward the resolution of engineering problems in machine building, an increase in the volume of general-science "work in progress" for the future, the timely summarization of progressive experience and the forecasting of trends in the development of leading sectors of machine building. Associates of the Leningrad Branch will also conduct an evaluation of the technical level and determine the need for the new equipment products and work on creating optimal methods for managing the potential of machine building, as well as seek effective ways of incorporating automated systems, complexes and whole production lines in machine building.

This circumstance is also significant. The experience of many years of creative collaboration of the Institute of Machinery Science with such production associations as the Leningrad Metallurgical Plant, the Kirov Plant, Elektrosila and others is already being utilized in formulating a theme plan for the research of the branch and the interaction of the young scientific institution with Leningrad industry. The discussion concerns the cooperative utilization of already existing experimental-test facilities, the manufacture of prototypes, the conducting of physical testing, the acceleration of preparation processes for series production and the increase of the qualifications of industry specialists.

The principle of definite self-recoupment is common to all of our branches. They should earn approximately 40 percent of the funds they need "for living" themselves, concluding business agreements with the corresponding industry enterprises.

I would like to note, however, that the organization of the branches of the Institute of Machinery Science is not the only method of strengthening the machine-building subdivisions of the USSR Academy of Sciences. We are also not forgetting the traditional ones--the organization of new research institutes. In December of last year, for example, an academic Institute of Problems in Metals Superplasticity was formed in Ufa. A process-design bureau and a test plant also located in Ufa were attached to this institute.

Beyond the Limits of the Known

[Question] Do you have in mind the study and utilization of the phenomenon of superplasticity discovered at one time by Academician A. A. Bochvar?

[Answer] His as well. You and I have already discussed the improvement of the surface features of parts with the aid of modern reinforcing processes. But after all, much can be achieved if we also proceed along another more complicated but also favorable route--improving the structure of the metal itself. The essence of the phenomenon of metals superplasticity is as

follows. It turns out that by choosing a certain temperature and rate of deformation of parts, the formation of the crystal structure in the metal or alloy can be controlled by the process itself. In this case the forces needed for, let's say, the stamping of parts are reduced by several times. But that is not all. After this processing, the part has only small residual internal stresses or none at all. Therefore, fatigue cracks do not appear and this means that the life and serviceability of this part are increased by several times. Manufacturing processes today, created on the basis of the effect of metals superplasticity, are already beginning to be incorporated in machine-building practice.

Naturally, however, all of the fine points of this complicated effect are still not clear to us. The collective of the new academic institute will be occupied with problems in the physics and mechanics of superplasticity deformation, develop physical and mathematical models for the mechanism of superplasticity flow, create methods for converting industrial alloys to a superplasticized state etc.

[Question] Konstantin Vasilyevich! You spoke of the work of the interbranch complexes and the new academic institutes along with the organization of the branches of the Institute of Machinery Science, but you have not spoken of the developments of the associates of the Institute of Machinery Science itself, of which you are the director.

[Answer] The subject matter of our institute is extensive, and therefore I will limit myself just to individual examples of practical developments.

The Newest Equipment

Our laboratory for reliability problems of robot-equipped systems has been organized at the Krasnyy Proletariy Machine-Tool Building Plant. Thanks to the joint labor of the scientists and production workers, it was possible to create in a short time an experimental-test prototype of a fundamentally new type of robot based on the effect of resonance. The power requirements were thereby reduced by 5-7 times, and metals consumption--through the application of composite materials--by roughly a third, while the reliability of the robot was increased by several times.

Also developed at our institute was a laser process complex with programmable displacement of the beam along the surface of the part being processed. These complexes can be successfully utilized in flexible automated production.

Today, composite structural materials are, if it can be expressed thus, "coming into fashion," that is, those where the polymer or metal is reinforced with carbon, boron, silicate or even organic-compound fibers. Using such materials, a weight reduction can be achieved along with an increase in the strength and longevity of the parts. But which composite material to choose? After all, the process engineers today can devise a practically endless number of them! It turns out that the features of the needed composites can be predicted. Unique algorithms and programs for the optimal planning of

composite structures have been developed at our institute. Their utilization allows a weight reduction in composite parts of 20-30 percent compared to traditional structural materials.

The associates of our institute and the workers of the production association of the Leningrad Metallurgical Plant are the authors of another interesting development. The discussion concerns promising methods of repairing large equipment that were created only after deep study of rupture mechanics. Large hydraulic turbines, mining equipment and road-building machinery, for example, are already repaired by pouring a very viscous metal on the damaged spot. The defect can be "halted" without allowing it to reach a critical state.

Technological Changes

I cannot omit the use of vibration and ultrasound in machine building. This area is also being successfully developed at the Institute of Machinery Science. Without vibration equipment it is impossible today to drill super-deep wells, enrich mineral ores, create pipeline transport and transfer free-flowing bulk freight. Pumps without parts that rub together were created on the basis of the principles of vibration transport. Not only liquids, but also so-called polyphase systems that contain solid occlusions, can be pumped with their aid. Vibration conveyors undoubtedly will be an important element in the transport systems of the "plants without people" of the future.

Ultrasound systems have an especial place among the varied vibration machinery and apparatus. By changing the intensity and spectral composition of ultrasound radiation, it is possible to influence the internal structures of the metal that determine its strength and plasticity. The promise of this process area is indisputable, since the theoretically achievable limit of metals strength machined with ultrasound is almost 100 times greater than under usual conditions. This signifies that even the best structural elements made today utilize only an insignificant portion of the enormous resources that are available to the metal in principle. But ultrasound aids not only in strengthening metal, but also in the machining of hard alloys, diamonds, ceramics (recall the ceramic internal-combustion engines being created!) and semiconductors--in short, those materials that are not subject to machining by traditional methods.

In concluding our discussion, I want to state the following. Yes, we are now conducting much intensive work on improving the whole machine-building complex of the country. But it should not be forgotten in this that we are far from conducting this work on a blank slate. Highly productive machinery for the continuous casting of slab blanks has been created in the Soviet Union along with equipment for automating various welding operations, including underwater ones, large furnaces for smelting forging ingots, unique hydraulic presses, various types of improved power equipment, modern metal-cutting machine tools and automatic rotary lines. I can declare with full responsibility that the country has at its disposal the most improved prototypes of new processes and equipment for the majority of the sectors of the national-economic complex.

Circulating What is Progressive

The most important thing today is to "circulate" these achievements more rapidly, which will facilitate the qualitative transformation of all of the productive forces of the country. Over the course of the upcoming five-year plan, we must accelerate the growth rate of machine building by 1.5 to 2 times and convert to the output of new-generation machinery and equipment. This will open the way for for the automation of many production processes, the application of the most progressive technologies and a reduction of the share of manual and heavy physical operations in industry.

In order to make all of this a reality, we are sharply accelerating the development of science and technology, especially their priority areas, and increasing the amount of basic research that has a direct application in engineering practice.

In demonstrating an especial concern for the development of science, the party has placed before Soviet scientists new and crucial tasks that correspond in significance and scale to the critical historical stage of today. Soviet scientists fully comprehend the enormous responsibility that is being placed upon them and are sparing no effort to justify the high trust of the party and bring to life the resolutions of the 27th CPSU Congress.

Retooling Costs, Benefits

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 8 (23), Apr-May 86 p 3

[Interview with USSR Academy of Sciences Central Econometrics Institute Director and Corresponding Member V. L. Makarov by NTR: PROBLEMY I RESHENIYA correspondent A. Mikhaylov under the rubric "The Economics of Acceleration": "The Cost of Renewal"]

> [Text] Economic and organizational problems in accelerating scientific and technical progress concern USSR Academy of Sciences Corresponding Member V. L. Makarov, director of the Central Econometrics Institute of the academy, who answers the questions of our correspondent A. Mikhaylov.

[Question] Accelerating scientific and technical progress, as emphasized in the resolutions of the 27th CPSU Congress, depends directly on the utilization of new equipment in production. But why is it still sometimes beneficial for users, and sometimes not?

[Answer] The benefit from any machinery, equipment or instrument is determined by comparing the expenditures for its acquisition and operation with the saving that it brings to the consumer.

The consumer is interested most of all in high quality in the new equipment. He always considers it from the point of view of productivity and

longevity, estimates the size of operating expenditures and makes an all-round comparison of the "old" and the "new." And if one takes into account that expenses for the operation of equipment, as a rule, are substantially higher than expenditures on its creation, then one can understand the consumer, who dreams of an innovation with the lowest possible operating expenses per unit of useful work.

[Question] Here, probably, it is pertinent to touch on the question of prices for new equipment...

[Answer] To strengthen their influence on accelerating scientific and technical progress is one of the topical problems that was discussed at the party congress. Prices--ideally--are set to ensure the constant influx of new equipment into the national economy. And in setting them, it is necessary to take into account the technical and economic characteristics of the new equipment and its consumer features.

[Question] It is well known that the basis of expanded reproduction is the profitability of production--a most important component of the development of productive forces. But the great "inertia" that exists today in the system of formulating and reviewing prices itself is leading to a disproportion between them and socially essential expenditures for production. What does this lead to in practice?

[Answer] The coal industry, for example, has become unprofitable. The miners today must produce coal at great depths and bring into economic circulation strata that are more difficult to access and have less capacity. At the same time, let's not forget, prices for building materials were increased in recent years, the cost of machinery and equipment has increased and intersectorial services have not gotten any cheaper. In short, socially essential expenditures for the production of a ton of coal have grown, while prices for it have lagged behind this growth. An analogous picture can be observed in several other sectors of the national economy as well. By the way, most often they do not have enough money for technical retooling--expenditures for new equipment are also growing, insofar as its complexity is increasing continuously. The managers of other departments see the way out of the resultant situation as constant appeals for additional budget allocations: the price imbalance also makes these sectors unprofitable, and they simply do not have funds for technical reconstruction and the incorporation of the latest achievements of science and technology. But miracles do not happen in economics. Additional allocations do not appear out of thin air, but are withdrawn from other profitable and progressive sectors. As a result, scientific and technical progress is slowed there as well.

[Question] In order to overcome this slowing, serious corrections should probably be incorporated in pricing policy?

[Answer] An axiom of technical retooling is that the creation of new and the modernization of existing equipment should always be linked with a reduction in expenditures per unit of useful work that it executes. Two simple but important conclusions follow from this. First, prices for new equipment must be set in direct dependence on its user features. After all, new equipment is

not an end in itself, but just a means of satisfying this or that social need. Second, in no case can it be permitted that the assimilation of the new equipment into production worsens the indicators of the enterprise that undertakes it. This means that prices should not only compensate for losses of the enterprise in production volumes and incentive funds, but must also increase the vested interest in the continuous acceleration of product output.

[Question] So then, let's suppose that an enterprise has begun to produce on improved equipment. It has less idle time and decreased operating expenses. The user indisputably benefits from this, since he gets additional profits. How can the producer plant get a vested interest?

[Answer] I think this can be done through a redistribution of these profits among the producer and user. Let's say that a portion of the income is given to the developers and manufacturers of the equipment, another portion to the user, and a third to the state budget. What these "portions" are should naturally be established by planning organs oriented toward the economic saving for the national economy.

[Question] The vested interest of production workers in accelerating scientific and technical progress can possibly be stimulated by the rational utilization of a whole series of already existing indicators...

[Answer] Yes, but I would like to make a reservation at once. By way of example, a high indicator for the standard straight output can be achieved by the enterprise in the first years of assimilation of the new equipment, since the labor-intensiveness of production increases objectively. But after all, the sense of scientific and technical progress objectively consists of the opposite. We must incorporate incorporate all kinds of improvements so as to reduce sharply this labor-intensity.

Analogous shortcomings are characteristic of other volumetric indicators as well, although, it is true, to a lesser extent. They not only do not "nudge" the enterprises toward a reduction of raw-material, power and material and technical resource expenditures, but sometimes directly hinder it. Practice is trying to overcome somehow the imperfect nature of volumetric indicators. Such planning evaluation criteria as growth in the output of high-quality products and the fulfillment of targets for the reduction of their cost have been introduced, limits for the expenditures of principal materials have been established and so on. They are called upon to transfer the center of gravity from quantitative to qualitative indicators. The resolutions of the 27th CPSU Congress orient us toward this. They require improving the system of prices so as to reflect more fully just these qualitative indicators.

[Question] Let's move on now to the concerns of those who utilize the new equipment and technology, and dwell on the problems that the user encounters.

[Answer] Currently the actual customer for all basic economic products is USSR Gosplan. Interaction of users and the producers in this, as a rule, occurs only in the process of coordinating the technical requirements for the products acquired according to the funds. Due to this, the responsibility of of the customer for the development of the new has declined quite without

justification. In a number of cases, the function of customer has gradually been transferred to the sectors that manufacture the products. The consequences of such a "role reversal" are quite apparent: some producing sectors are beginning to dictate to the customer what equipment he needs...

[Question] How can the situation be changed, how can production be oriented toward satisfying the requests of the users

[Answer] One of the simplest solutions is to transform the users of the products into the customers, moreover without intermediaries in the form of trade and distribution organizations. The layout of such a process could, for example, look like the following example. The sector, endowed with the rights of customer and the corresponding resources, sends a program for the production of equipment it needs to USSR Gosplan. The aggregate of these programs both makes up the basis of the state five-year plan for the production of machinery and process equipment and of that plan which is formulated by the customers themselves and, naturally, fully satisfies their needs.

[Question] It is not necessary to be a specialist to understand that the efficiency of the work on technical retooling in our national economy is greatly determined by the efficiency of the financial mechanism. What problems in its improvement are most topical today?

[Answer] First and foremost, probably, it is necessary to reconstruct to a certain extent the very system of forming and utilizing the sources from which the development of science and technology are financed. Principal today is the so-called unified fund for the development of science and technology. It is created through profits from the activity of production and scientific production associations and enterprises. It has been deemed expedient today that this profit or the major portion of it remain at their disposal. This measure will make it possible for the enterprises and associations to implement more energetically the development and incorporation of new equipment. Another matter--and this must always be remembered--is the major and difficult work important for the sector overall. The source of its financing is that portion of the profits that remains "in the hands" of the sector.

The methodology of the formulation of the unified fund for the development of science and technology itself requires review. Up to now, only the profits from production business activity enters it. But after all, the receipt of planned profits depends on a great multitude of factors. It often happens that the profit indicators are not fulfilled due to a series of objective causes. Then the deductions to the unified fund for the development of science and technology are automatically reduced, as are the opportunities for the ministries and the enterprises and associations themselves to finance promising work vitally important for them. What is more, the instability of profits as the chief and sole source for financing the formation of a unified front leaves the "weak" enterprises without funds for reconstruction and technical retooling altogether. And this is quite incorrect in principle, since it is namely them, with the aid of new equipment and progressive technologies, that we must bring to the proper level of profitability.

Practice shows that the interrelationship of expenditures for scientific research and experimental design work, as well as for the assimilation of new produced, financed from the unified fund differ sharply in various sectors. This naturally leads to a certain "warping" in the development of scientific and technical progress. In order to avoid this, it would be intelligent, to my view, to establish a proportion between these two types of expenditures in the form of flexible standards for the division of the unified fund. Let's say that if the body of the products of a given sector do not meet modern requirements, then the share of expenditures for scientific research and experimental design work should be increased.

In short, the implementation of the whole set of measures for improving the management mechanism projected by the resolutions of the 27th CPSU Congress, only parts of which I have touched upon, will facilitate the decisive acceleration of scientific and technical progress.

More Rapid Technology Assimilation Urged

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 8 (23), Apr-May 86 p 2

[Article by USSR Minvuz [Ministry of Higher and Secondary Specialized Education] Scientific Research Operations Main Administration Deputy Chief E. Antipenko under the rubric "The Pulse of NTR [Scientific and Technical Revolution]": "The Potential of Higher-Educational Science: Accelerating Applications"]

> [Text] It is time not for recommending, but for planning the incorporation of higher-educational developments, feels the author of the article.

Fourteen thousand scientific research operations are being conducted today at the higher educational institutions of the country. In the last five-year plan, higher educational institutions participated in 162 of the 174 nationwide scientific and technical programs. Over four years of the last five-year plan alone, more than 64,000 higher-educational developments were incorporated into the national economy with a proportionate economic saving of 7.4 billion rubles. Every year more than three hundred higher-educational developments become a part of the sectorial plans for the creation and incorporation of new equipment.

As practice has shown, the most efficient form for the broad incorporation of higher-educational developments is their immediate inclusion in the state plans for social and economic development. The dynamics here are: 28 developments were included in the state plans in 1984, 34 in 1985 and approximately 50 in 1986. The opportunity exists to double this number in the 12th Five-Year Plan.

Among our developments are such revolutionary processes as melting in liquid baths (Moscow Institute of Steel and Alloys) and a new type of rolled metal (Chelyabinsk Polytechnical Institute).

It should be emphasized that the potential of higher-educational science is quite impressive. But the scope and rate of the advancement of developments into practice is not satisfactory. Here are some examples.

The dual-action screw press developed by the MVTU [Moscow Higher Technical School] imeni E. N. Bauman is intended for the manufacture of fine parts for complex configurations. Due to the fact that the part being machined in a closed matrix is subjected to a double impact for each passage of the punch, it was possible to reduce the number of traditional process operations. The advantages of this press are indisputable: metal consumption is reduced to 40 percent, the labor intensity of the subsequent machining is reduced to 30 percent, power consumption is reduced and the productivity of forge machining is increased. The press was certified as being of the highest category of quality. This is a unique piece of equipment without equal in world practice. Nonetheless, the state plan for 1985 includes the manufacture of only four such presses, although the economic need for them is much greater.

The fate of the Gorizont apparatus developed by the Moscow Mining Institute for automatic precision drilling was analogous. It allows the standardization and intensification of the drilling process, the reduction of power consumption and the monitoring of the condition of the drill bit at the hole bottom. It also eliminates the occurrence of occupational illnesses among the workers and reduces the workload. Notwithstanding the great need for such an instrument, the organization of its production at the enterprises of Minpribor [Ministry of Instrument Making, Automation Equipment and Control Systems] has not been possible.

The efficacy of higher-educational science is reduced by the insufficiently powerful design and industrial-test base of the higher schools. This difficulty is being overcome by way of cooperation of the higher educational institutions with the enterprises organizations of many sectorial ministries and departments.

We would consider it expedient to simplify substantially the review of technical innovations created by higher educational institutions.

I think that we could incorporate more quickly the results of research if the sectorial departments and the combined department of science and technology of USSR Gosplan, with complete information at their disposal, determined the locations and amounts of their practical utilization. To our view, this would be in full accordance with the principles of centralized planning. Until then the higher educational institutions themselves have to seek out enterprises that could prepare the innovations for series production.

Our developments also run across another substantial obstacle. There are well-known instances where the experts of sectorial institutes reject them due to narrow departmental interests. As examples, we can recall the "passage through purgatory" of the analog computing complex developed at MIFI [Moscow Engineering Physic Institute] or the whole range of machinery using impulse power sources developed at the Kharkov Aviation Institute.

Unfortunately, the resolutions of all the interdepartmental commissions that review our proposals for incorporation are in the form of a recommendation and are not compulsory for the sectors.

Not long ago, we appealed to USSR Minstankoprom [Ministry of the Machine Tool and Tool Building Industry] for assistance with a list of scientific and technical problems urgent for the sector. We circulated this list among the higher-educational ministries of the union republics. I am confident that Minstankoprom will receive the necessary proposals in the near future. If the other ministries follow the example of the machine-tool builders, our collaboration with them will become extremely fruitful.

Role of Computerization

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 8 (23), Apr-May 86 p 6

[Interview with Academician Germogen Sergeyevich Pospelov, chairman of the scientific council of problems of artificial intelligence, by O. Lebedeva under the rubric "Computers and Us": "What the Computer Can Do"]

> [Text] It is no secret that illusory conceptions of the unlimited possibilities of artificial intelligence and the endowing of computers with practically all human characteristics is typical of many, even specialists of computer technology. One frequently hears that someday an intelligent robot will not only become a skilled translator of texts and a sensible assistant in any sphere of human activity, but will even be able to reason independently and have feelings...
>
> That is apparently why Germogen Sergeyevich Pospelov began the discussion with the assertion:

[Pospelov] I will state right off that there is no artificial intelligence in the sense that the majority of people now assign to the phrase.

Computers really do "play" chess, synthesize musical compositions and texts and the like. It is as if--I emphasize, as if--they are working creatively. This is where the name "artificial intelligence" came from in its time. But in point of fact it does not compose music itself--with inspiration and the desires of reason--but just follows a program composed by man, blindly subordinate to it. After all, we don't say of a violin that it's component parts are intelligent. So why have microcircuits suddenly "gotten smart?"

The tragedy is moreover that not only are the "uninitiated" misled, but so are the specialists. A so-called "anthropomorphic fog" has been hung over computer technology and over automated processes in particular. This situation is observed not only in this country, but its danger is mentioned in the United States and other developed countries.

[Question] Why is this confusion dangerous?

[Answer] In my opinion, this greatly hinders the resolution of vital tasks. But that is not the whole matter.

Network planning methods began to be employed at one time. The managers of enterprises most often acted in the following manner. They questioned the executors on which operations should be executed so that each of them could begin their operation. On the basis of these answers and using computers they composed a network schedule. The manager, without looking, wrote "approved" on it, and then the plan was disrupted. "Why was the plan disrupted?" they asked the manager. "What's it got to do with me?" he replied. "It's the machinery, science that's at fault..."

As a matter of fact, planning is an intellectual function of the manager. It is precisely the manager who should not only review the data suitable for machine processing, but should understand (sometimes even intuitively) and take into account a body of other factors: the character of the executors, their interest level, the probability and scale of unforeseen obstacles and so on and so forth. The effect of the "anthropomorphic fog" that I mentioned in manifested precisely in the fact that they are trying to make the machine a person. Whence comes an overestimation of its capabilities and the shifting of one's own responsibilities to the equipment.

And what if it is necessary to make a decision under critical conditions, when an error can become unjustifiable? This relates in particular to the capabilities of the beginning of "star wars." If the decision turns out to be erroneous, once again they will refer to the machine: the machine messed up, they'll say. In point of fact only people stand behind this decision--the people that wrote the program, and the people that put the machine into action. The crime was committed at the instant the program was written.

[Question] What are, in your opinion, the limits of rational interaction between computers and man?

[Answer] On one hand, there exists as before a circle of operations that are accessible only by computers: the solution of cumbersome computing tasks which a shortage of time, under conditions unsuitable for man etc. On the the other hand, there are well-known man-machine systems in which the person interacts with the computer and corrects its actions. These are ASUs [management automated systems] and the information-retrieval, information-logic, and lately the so-called expert systems.

[Question] What new "abilities" are they endowed with?

[Answer] So-called intelligent information-retrieval systems should come to replace information-retrieval systems. They have a much greater information-inquiry fund than their predecessors and can output the required information to the user even in cases where his request is imprecisely formulated.

The expert systems are now the most widespread of the new systems. They should accumulate the experience of poorly formulated spheres of knowledge

such as medicine, history, biology etc., and create from it a unique electronic inquiry-reference for the "narrow" specialist.

Another example. Logical-calculation systems. They are called upon to execute a multitude of procedures utilized in planning, design and dispatching tasks.

Thus it is namely the man-machine mode that should become the main reference point in work on artificial intelligence.

[Question] How complicated is the process of interaction with such computer systems?

[Answer] The computer-assistant can be utilized in practically all areas of science, production and daily life. This means that the computer should be adapted for contact with any ordinary person who has only the rudiments of computer knowledge. The problem of the interaction of such people with computers should be resolved as quickly as possible.

Today we are accustomed to the fact that between the computer and the specialists that resolve their tasks with it there exist intermediaries--analysts and programmers. They transform the initial information from the professional language of the user first into a mathematical model, and then into a program comprehensible to the computer. Thus there stand between the end user and the computer, as a rule, not one but two or even three intermediaries.

In order that the computer be able to prepare a program for the resolution of tasks according to an oral description of its conditions, the computers are supplemented with a so-called "intelligent interface" that provides for contact between the computer and the professional language of the user.

[Question] Germogen Sergeyevich, what do you feel is the central problem of artificial intelligence today?

[Answer] The presentation of any kind of knowledge in a form suitable for machine processing.

As I was saying, any utilization of a computer presupposes a triad: a mathematical model--an algorithm for its solution--a program. Wonderful mathematical models have long ago been worked out in mathematics, physics and mechanics.

There are not similar models, however, in medicine and the social and human sciences.

[Question] But then programmers and analysts are still needed.

[Answer] Only to create the intelligent interface, not for machine interaction. As I was saying, any user with computer literacy should interact

directly with the computer in "his own" language. That is, in the language of the planner, the designer, the geologist, the architect and so on and so forth.

[Question] That is, every sphere of knowledge should have people that formulate the data of that sphere in a form suitable for its entry into a computer?

[Answer] Quite correct. Abroad they are called knowledge engineers. On one hand, they know the subject well (medicine, for example), and on the other, are able to formulate their knowledge in such a manner that the computer can "comprehend" it.

[Question] Where are knowledge engineers trained?

[Answer] Nowhere and by no one. Neither here nor (so far as I know) abroad are there even instructors yet to train other instructors in this specialty. Across our whole country you could collect maybe a hundred specialists that have the necessary knowledge and skills in this matter. This problem requires urgent resolution.

12821
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PANICHEV NAMED MINISTER OF MACHINE TOOL BUILDING

Moscow IZVESTIYA in Russian No 197, 16 Jul 86 p 3

[Text] In the Presidium of the USSR Supreme Soviet--the Presidium of the USSR Supreme Soviet has appointed Comrade Nikolay Aleksandrovich Panichev to be USSR minister of machine tool building and tool industry.

Nikolay Aleksandrovich Panichev was born in 1934. He is a Belorussian, and he has been a member of the Communist Party of the Soviet Union since 1955. He is a graduate of the Leningrad Polytechnical Institute, and of the Academy of the National Economy at the USSR Council of Ministers.

He served in the Soviet Army during the period 1953-1955. After graduating in 1957 from a vocational trade school, he worked as a lathe operator at the Leningrad Machine Tool Plant imeni Il'ich of the Ministry of the Machine Tool Building and Tool Industry, and later as a designer and shop superintendent at this plant. From 1967 to 1975, he was elected deputy secretary of the party committee and secretary of the party committee of the Leningrad Machine Tool Building Production Association imeni Sverdlov.

In 1975 he was appointed director of the Machine Tool Plant imeni Il'ich and head of the special design bureau for grinding equipment; in 1980 he became head of the All-Union Industrial Association for Production of Precision Machine Tools, and a member of the board of the ministry. In 1981 he became deputy minister. Since 1983 he has served as first deputy minister of machine tool building and tool industry.

He has been awarded the orders of the October Revolution, the Red Banner of Labor, and "Badge of Honor," and a medal.

(A photograph of Panichev is given.)

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SOVIET-BULGARIAN FLEXIBLE PRODUCTION MODULE

Moscow KOMMUNIST in Russian No 125, 27 May 86 p 1

[Article by Ye. Verlin; K. Stel'mashev, correspondents (Moscow)]

[Extract] Right after coming to the "Stankokonstruktsiya" Plant, a numerically-controlled circular grinding machine developed by Bulgarian machine-tool builders changed its name. By mating it with an industrial robot, designers of the Moscow research-and-production association "Enims" (Experimental Scientific Research Institute of Metal-Cutting Machine Tools) transformed the semi-automatic machine tool into a flexible production module.

This has increased the productivity of the machine by 20 percent. In conditions of two-shift operation, each such module frees three highly skilled grinders.

Candidate of Technical Sciences V. Shuvalov, an "Enims" section head, said: "The development of this equipment, which was in collaboration with Bulgarian colleagues, is bound to contribute to the fastest possible introduction of highly efficient technology in the economy."

In its capacity as the USSR Ministry of the Machine-Tool Building and Tool Industry's chief organization for the formulation of technical policy in the area of metal-working equipment, "Enims" is establishing close collaboration with related enterprises in fraternal countries. In cooperation with specialists of the German Democratic Republic and Hungary, flexible modules based on new machine tools have been developed, and a joint design bureau has been set up with Polish machine-tool builders.

The machine-tool builders' task is to speed up significantly the introduction of results of designers' creativity in industry. The association intends to achieve this through the active use of a computer-aided designing system and, what is very important, through the restructuring of the very process of mastering new technology. It has been decided to begin production of groups of parts as individual development stages are completed, in order to have the entire set of assemblies of the future machining aggregate available by the time the project is completed.

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OTHER METALWORKING EQUIPMENT

IMASH DEVELOPS NEW LUBRICANTS, NC TOOL METERING HEAD

Moscow NTR: PROBLEMY I RESHENIYA in Russian No 8 (23), Apr-May 86 p 5

[Article "Developed at the Academy of Sciences USSR Machine Sciences Institute"; capitalized passages published in boldface]

[Text] A broad range of fundamental research whose results will be widely used in various sectors of the national economy is underway at the Machine Sciences Institute imeni A.A. Blagonravov.

Here we will discuss only six of these projects.

A NON-TOXIC, WATER-BEARING COMPOUND designed to replace mineral oils in closed-type transmissions (cogged and worm reduction units) and in hydraulic systems where the case temperature does not exceed 80 degrees C. The compound is non-toxic, well soluble in water and does not pollute the environment. It has successfully undergone operational testing at several enterprises in the Ivanovsk area. The total annual impact of its use as a replacement for I-20 industrial oil at three enterprises was 200,100 rubles.

LASER HARDENING OF AGRICULTURAL ENGINEERING COMPONENTS operating under severe friction wear conditions leads to a marked increase in surface layer hardness. The procedure's advantages include high processing speed and minimal component shape distortion. There is a 2- to 5-fold increase in wear resistance. The expected economic impact is 1.7 million rubles.

BRITTLE, STRAIN-SENSITIVE COATINGS, depending on the nature of their fissure distribution and density, permit identification of areas of highest and lowest stress, determination of the direction of primary tension and compression forces and measurement of their extent. This greatly facilitates the time and volume of design and development work involved in the selection of an optimum design variant and its refinement in bench and live testing.

Introduction of this method at the Taganrogsk State Special Design Office for grain harvesting and self-propelled chassis produced an economic impact of 300 thousand rubles.

A HIGH-SPEED CYCLICAL INDUSTRIAL ROBOT WITH ENERGY REGENERATION removes the operator from the danger zone around a press and frees him from the monotonous work of loading blank magazines. Compared to other types of cyclical industrial robots, labor productivity is increased 2.3-fold and energy consumption is reduced 8- to 10-fold.

The prototype batch of these robots has been produced. The economic effect of the introduction of each robot is 2.5 thousand rubles annually.

SELF-LUBRICATING MATERIALS WITH NEW SOLID LUBRICANTS obtained by thermochemical processing and powder metallurgy are very promising for use in dry friction components of high-vacuum systems, in vacuum rolling and in electrovacuum technology. They are used to produce slip pads, bearing separators, tapered rollers for bearings and spur gears. The economic effect of their introduction was 1 million rubles.

A METERING HEAD FOR NC MACHINE TOOLS provides information on the geometric parameters of machined surfaces. When compared to similar domestic and foreign models it is characterized by a simple design, lower cost and high reliability. The metering head provides the capability of receiving several control signals which are used by the machine tool control system. This in turn permits a reduction of measurement times. The economic effect of using this type of head on NC lathes at the "Krasnyy proletariy" plant is 515 thousand rubles per year.

12746
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OTHER METALWORKING EQUIPMENT

LATHE SPINDLE WITH MAGNETIC BEARINGS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 146, 24 Jun 86 p 2

[Text] Scientists of the Pskov affiliate of the Leningrad Polytechnical Institute have devised and produced a spindle which saves machine-tool operators much trouble and expense. Its principal merit is that it ensures very high grinding, milling and drilling speeds and machining of the highest quality at the same time.

This was achieved by replacing conventional antifriction bearings with active, magnetic ones.

The spindle picks up speed rapidly. Its rotor has a speed of 120,000 rpm. Standard bearings could not hold up at such a speed: the maximum that they are capable of is 9,000 rpm. Moreover, after 150-200 hours of operation, standard bearings are no longer capable of ensuring good performance by a spindle. One has to stop the machine, take apart the spindle and change the bearings. The service life of the magnetic bearings has proved to be practically unlimited--they have continued to operate even after 5,000 hours.

All of this is due to the fact that the rotor of the new spindle is not in contact with any non-moving parts. In fact, it is suspended in mid-air, kept in the proper position by forces of magnetic attraction. The rotor cannot be forced to change its position: an automatic device which controls the magnetic forces is activated instantly and stabilizes the spindle. The rotor can operate equally well in a vacuum and in conditions of high and low temperatures.

A prototype of the electric spindle has successfully passed industrial tests at State Bearing Plant No 4 in Kuybyshev.

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OTHER METALWORKING EQUIPMENT

ELECTRIC WELDING EQUIPMENT INSTITUTE'S R&D GOALS

Leningrad LENINGRADSKAYA PRAVDA in Russian No 153, 4 Jul 86 p 1

[Text] The personnel of the All-Union Scientific Research, Planning-and-Design and Technological Institute of Electric Welding Equipment are working productively on development and introduction of new types of welding technology.

During the last 5-year plan, 317 types of new equipment were introduced into production as a result of developments of this institute alone. This equipment yielded an overall economic benefit of more than 514 million rubles, or 12 rubles for each ruble spent. The proportion of equipment of the highest quality category in the overall volume produced from the institute's development was 56.3 percent, and that of developments surpassing the world standard was 28.5 percent.

As required by decisions of the 27th Congress of the Communist Party of the Soviet Union, the institute's scientists, designers and technologists are channeling their efforts into further improvement of production, and expansion of the technological capabilities of welding equipment through the use of microprocessor control equipment in the 12th 5-Year Plan. The proportion of equipment of the highest quality category will increase to 70 percent and the proportion of developments that surpass the world standard will grow to 33 percent.

(The photograph shows Candidate of Technical Sciences A.V. Ivannikov, head of a laboratory, who has developed many types of equipment.)

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OTHER METALWORKING EQUIPMENT

NON-TUNGSTEN ALLOYS FOR RECONDITIONING MACHINE PARTS

Moscow KRASNAYA ZVEZDA in Russian No 164, 15 Jul 86 p 4

[Text] Certain machine parts operate in especially harsh conditions; they wear out quickly, and they have to be replaced with new parts. Sometimes a part that weighs hundreds of kilograms loses only a few millimeters of metal to wear, and the entire part is sent for remelting in order to restore these lost millimeters.

Specialists of the All-Union Scientific Research and Design Institute of Refractory Metals and Hard Alloys have developed new materials for reconditioning machine parts by the method of surfacing. They contain no tungsten, but at the same time they are practically equal to tungsten-containing materials in their performance qualities. The service life of parts that are reconditioned with them is increased by 2-10 times.

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ROBOTS WITH GRIPPING DEVICES THAT ADAPT TO SHAPE OF OBJECTS

Moscow PRAVDA in Russian No 142, 22 May 86 p 1

[Article by T. Yesil'bayev, correspondent (Alma-Ata)

[Extract] Working models of robots of an original type have been developed and built in the republic robotics center at the Kazakh University.

Authors of the inventions call them 'toys.' These miniature mechanisms really do look like toys for kids' play. What is original about them?

"Important ideas are incorporated in these small models," explained member of the Kazakh Academy of Sciences U. Dzholdasbekov, who is president of the university and director of the robotics center. "As a result of long research, we have introduced changes in the mechanics of robotic manipulators and have developed mechanisms of a high class."

The principle which served as the basis for development of a lifting device is the one used in artificial limbs for humans. The main advantage of these prostheses is that they are convenient for amputees: they simulate the movements of arms or legs to the maximum possible extent.

Of most interest is a working model of a manipulator gripping mechanism. Specialists of the university developed a manipulator which is capable of changing the contours of its 'fingers,' depending on the shape of the object that they are supposed to grip.

"When robots are in series production, technical quality control of them takes a good deal of time and requires a large amount of manual labor," said docent L.I. Slutskiy, one of the authors of the invention. "For the first time we have succeeded in making automated test stands which expedite this process appreciably. Information from these stands is processed by a microcomputer. The stands can serve as simulators for teaching operators how to program industrial robots."

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IMPROVEMENT OF GRIP DEVICES DESCRIBED

Moscow MASHINOSTROITEL in Russian No 6, Jun 86 pp 11-12

[Article by V. D. Darovskikh, engineer: "Improvement of Gripping Devices"]

[Text] In cases where one industrial robot (PR) has to service several objects different in shape, physiomechanical properties, geometric dimensions and other parameters, the utilization of vacuum grips,among which contact and perforated suction disks are most widely used,is very promising. Standard contact disks can also operate with a large list of parts which is important in small series production. They are capable of gripping and moving products made of glass,plastics, ceramics, sheet material as well as less rigid products (for example,made of rubber, cardboard and paper). A PR with a pneumatic drive, equipped with a perforated grip (ZU) can be used successfully to automate production processes involving stacking, assembly, sorting and stamping parts that have at least one flat surface of arbitrary configuration. Such a device is capable of gripping one or several parts simultaneously without additional readjustments.

Fig. 1

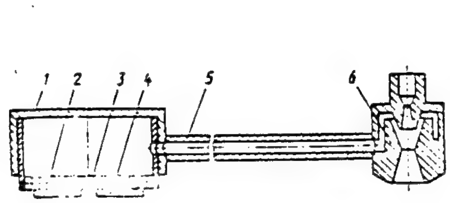
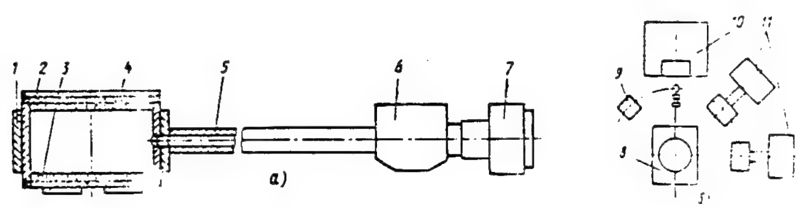


Fig. 2



The design of perforated grips of industrial robots with pneumatic drives consists of housing 1 (Fig. 1) of a vacuum chamber, vacuum line 5, ejector 6, flange 2 with a multiplicity of holes and, for example, a sealing rubber gasket 3. With fully open perforated holes, the ejector creates a pressure

lower than the atmospheric pressure in the vacuum chamber of the housing. When part of the holes is overlapped by the surface of the gripped part, the vacuum in the chamber increases. As a result of this, a suction force acts on the part. This force is proportional to the product of the pressure difference by the total sum of the hole areas overlapped by the surface of the part, as a result of which the transported parts are gripped and retained.

To expand the technological possibilities of the ZU it is equipped with an additional flange 4 (Fig. 2a), the hole diameter of which is bigger, while their number is smaller as compared to the holes in the plane of initial flange 3. The upperpplane of flange 4 is sealed by plate 2. The entire structure (patent application No 3834274) is rigidly connected to an industrial robot through device 7 for angular positioning which can turn housing 1 of the vacuum chamber by 180°. The operation of the proposed ZU is similar to that of the previous one. However, when changing parts in case of the readjustment of the robotized technological complex shown in Fig. 2b (where: 10 -- basic technological equipment; 8 -- industrial robot; 11 -- devices for piece-by-piece distribution of parts; 9 -- device for distribution of the sealing plate), the gripping device is readjusted. For this purpose, on signals from the control system, robot 8 carries the ZU to device 9 to issue sealing plates 2 (Fig. 2a). Power to ejector 6 is cut off and plate 2 is seized by device 9. The robot moves the ZU down vertically, while device 7, for angular positioning,turns it by 180° with respect to the axis of vacuum drive 5. Now the opposite initial plane of the flange with perforated holes is located above the sealing plate. The robot lifts the ZU to the plate and after the ejector is cut into operation, carries it to one of the devices for the distribution of parts. The force which holds the sealing plate to the ZU with fully open perforated holes of the opposite flange, must exceed the force which holds the ZU by device 9.

The algorithm for RTK functioning can be equipped with logic function according to which the readjustment operation of the grip can also be done with the interaction of the latter with a specific device for issuing the part, when the part is not gripped after two-three attempts which occurs when they are soiled or have become wet.

The grip of this design can be readjusted automatically and with high productivity for gripping parts of various configurations. Moreover, the ZU in combination with the controlling device is able to evaluate the quality of the surfaces to be gripped and eliminate unproductive time losses for idle movements of the PR. This increases the reliability and productivity of the PR.

The following stage in improving the ZU is to divide the vacuum chamber by partitions 1 (Fig. 3) into central and peripheral cavities. Bushings 2 with conical saddles are mounted in the partitions interacting with conical gates 3. The latter are rigidly interconnected with a rod selected so that when sealing one of the gates of the corresponding saddle a gap remains between the other gate and the saddle. Vacuum line 6 is mounted in the support to which flange 13 is tied by slide bars 11 for securing the ZU to the robot. Cylinder 9 mounted on guides 8 interacts with the external surfaces of the support and the vacuum line. Ejector 12 and cylinder 9 are connected to the power system through the control device.

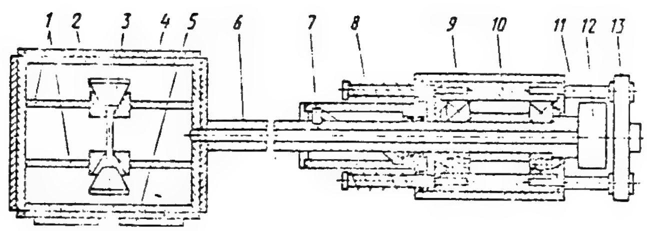


Fig. 3

At the start of operation the upper peripheral cavity of the ZU vacuum chamber is isolated from the central cavity tied by the vacuum line with the ejector. One gate closes the saddle by gravity. A gap is formed between the second gate and saddle of the bushing of the second partition; the peripheral cavity is connected to the ejector through this gap. When compressed air is fed through the ejector to the central and lower peripheral cavities, a pressure lower than atmospheric is created. This makes it possible to grip parts 5 when they interact with perforated gasket 4 because the overlapping of a part of the perforated holes by the surface of the gripped object leads to an increase in the rarefaction in the vacuum chamber.

The control system sends a signal to the cylinder when the ZU is readjusted to operate with another part. The cylinder begins to move with respect to the support of the vacuum line and along the guides, compressing the springs placed on them. With the mutual linear movement of the cylinder and the vacuum line along the groove in the hollow part of the cylinder, pin 7, attached to the vacuum line, slides. As a result, the vacuum line rotates 180° around its axis in the support bearings. The housing of the ZU and the ejector rotate simultaneously with the vacuum line. The lower and upper peripheral cavities exchange places. One gate closes the saddle of the upper bushing and a gap forms simultaneously between the other gate and lower bushing, while the central and peripheral cavities are again connected to the ejector.

On the reverse stroke, when the ZU returns to its initial position, power from the control system to the cylinder is cut off. Springs, expanding, move the cylinder to the left and pin 7, sliding along the groove in the cylinder, forces the vacuum line to rotate in the support bearing.

The grip, having adaptive properties to recognize the situation, makes possible its use for the automation of assembly work. Automatic readjustment of the ZU accelerates preparatory operations, increases the productivity of the process and reduces the number of fixtures required.

The replacement of a gravitational vacuum valve by a controlled one further expands the functional properties of vacuum grips.

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TYPICAL ROBOT-TECHNICAL COMPLEX

Moscow MASHINOSTROITEL in Russian No 6, Jun 86 p 12

[Article by G. A. Korolik, engineer]

[Text] The level of high production automation is based on the creation of flexible production systems whose introduction requires time and a certain amount of preparation for production. During this transition period of rebuilding production, the problem arises -- whether to robotize maximally the existing technological processes for machining parts by creating and introducing robotized technological complexes (RTK). These complexes must make possible the machining of parts of a wide list of products in any lots and any conditions of the time of assembly.

The PTImash [Planning-Technological Machine Institute] developed a set of nonstandard equipment on the basis of the "Brig-10B-MK" industrial robot for such an RTK to machine parts of solids of revolution types weighing up to 7 kg. This set includes readjustable loading-accumulating (ZNU) and storing devices, a support for the robot and a mobile guardrail. The ZNU consists of a detachable chain accumulator with a capacity of 100 intermediate products, a base and a device for rotating the chain (initially the accumulator was loaded manually).

The storing device is intended to receive finished parts after the last operation. It consists of a packing box, a cart, a base and transfer devices. The robot places 10 parts sequentially into each cell of the detachable readjustable packing box with a capacity of 100 to 150 parts. The box is unloaded manually.

The support under the robot makes it possible to advance the grip of the robot with fair accuracy with respect to the spindle axis of the machine tool. The height of the support and the movement of the robot along its place are regulated by screws.

The design of the RTK is reduced to the following. According to the technological machining process of a certain part a ZNU, a robot on a support and a safety guardrail are installed near each machine tool, no matter where it is located in the shop. All devices are oriented with respect to each other and the electrical circuit is wired. The RTK operation consists of the robot

gripping an intermediate product from the ZNU and loading the machine tool. After machining, the part is returned to its place and the machine tool is loaded with the next intermediate product. After all parts in the accumulator are machined, the accumulator is moved to the following operation at another RTK and in its place an accumulator from the previous operation is installed. At the RTK for the final machining of the part, there is installed a storing device in the packing box into which the robot loads parts machined by the machine tool. A fully loaded packing box is removed and transferred to assembly or to the warehouse, and a new box is installed in its place. The RTK operation in the automatic mode is implemented from the robot control panel.'

Taking into account the fact that the RTK is made up of typical devices, the time to design it is reduced sharply.

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ROBOTIZED COMPLEX FOR MACHINING STEPPED SHAFTS

Moscow MASHINOSTROITEL in Russian No 6, Jun 86 pp 12-13

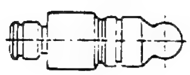
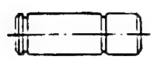
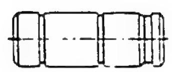
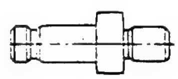
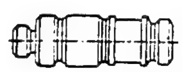
[Article by G. Ye. Gizova, engineer; S. I. Modnov, candidate of technical sciences; M. I. Irodov, A. F. Peretrukhin, engineers]

[Text] A robotized complex (RK) for turning stepped shafts includes a model 16K20F3S5 NC lathe and a two-arm model SN3308.0 automatic manipulator with an accumulator magazine. This complex, although similar to a typical MK-6783 machine tool technological module, is formed of a lathe and a manipulator acquired separately. Holes were bored in the rear workhead of the machine tool under the hydraulic cylinder for installing the complex; an additional movement guide was made in the lower part of the bedplate; control panels for the manipulator and magazine were installed on the machine tool control panel; driver plates (of three type sizes) were manufactured and installed to clamp the intermediate products.

The automatic manipulator loads the machine tool with intermediate products of solids of revolution type, removes machined parts and places them in the magazine-accumulator (the weight of intermediate products is up to 40 kg, diameter 20 to 125 mm. length 165-750 mm). The manipulator is equipped with two pairs of interchangeable grips each of which has an independent stroke. This makes it possible to clamp stepped and smooth intermediate products without losing the axial orientation.

The wide product list of machined parts made necessary a thorough technological preparation for the introduction of an RK. Working jointly with specialists of the Yaroslavsk Polytechnical Institute, specialists made an analysis of the parts to be machined according to design and technological criteria, dimensions, weight and sizes of start-up lots in production. This stage of technological preparation was completed with the development of a classification for the products using design and technological codes and for the separation into groups of geometrically and technologically similar parts. In grouping parts whose lots are 80 to 100 and more pieces should be primarily separated as should parts in small lots , but with relatively high labor-intensiveness of machining. It is inefficient to machine parts that do not satisfy these requirements in an RK, due to a sharp increase in unit costs for the readjustment of the equipment.

Parts machined on the RK

(1) Эскиз комплексной детали	(2 Основные размеры детали, мм			(3 Трудоемкость изготовления детали, мин
	(4 наибольший наружный диаметр	(5 наименьший наружный диаметр	(6 длина	
	60	—	280	0,12
	30	24,50	292	0,26
	40	35,50	428	0,30
	50	40	358	0,30
	59,50	24	298	0,25
	65	20	560	0,40

1 -- Sketch of part
2 -- Basic dimensions of part, mm
3 -- Labor-intensiveness of machining part, minutes
4 -- Maximum external diameter
5 -- Minimum external diameter
6 -- Length

The entire product list of parts (36 types) was distributed into six groups; a comprehensive part was created in each group on which a calculation was made of the labor-intensiveness of machining (see Table). The total number of parts for machining with the RK was over 27,000 pieces a year. with the labor-intensiveness of these parts being about 4000 hours. The loading RK coefficient with two operating shifts was 0.80 to 0.84.

In the following stage of technological preparation, technological group processes were developed. Here special attention was given to the selection of a progressive metal-cutting tool. Thus, the use of cutters equipped with polyhedral nonregrindable plates of VO-13 oxide (rhombic shape) and VOK-60 (trihedral and tetrahedral) ceramics, made it possible to finish the machining of steels and cast iron intermediate products with a cutting speed of up to 250m/min and feeds of up to 0.25mm/rev.

The introduction of the RK at the plant automated the machining of various type-sizes of stepped shafts, reduced the manufacturing cost by 27 percent, freed three workers conditionally and raised the standard of production. The saving from the introduction of two complexes at one plant was over 5000 rubles with repayment of the additional capital investments in 1.63 year's time.

2291
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MACHINE TOOL INSTITUTE TESTS ROBOTS FOR FLEXIBLE MACHINING

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 129, 4 Jun 86 p 1

[Article by V. Veprik, correspondent (Odessa)]

[Extract] The largest 'brigade' of robots in the country has begun to operate at a test facility of the Ukrainian Scientific Research Institute of Machine Tools and Tools in Odessa. Altering working conditions and making them more complicated, specialists here are developing flexible resettable systems (GPS) on the basis of the latest machine tools and machining centers, electronic devices and transport equipment.

"Not all of the robots passed the first phase of trials," said Candidate of Technical Sciences N. Reshetnev, director of the institute. "Out of 80 models, 20 of the most promising ones were chosen. We will continue to work on their improvement together with manufacturing plants. The ultimate goal of this work is to create the country's first flexible resettable system for lathe working.

"At the present time robots and automatic manipulators produced by different enterprises are not providing the desired effect in machine building. We have undertaken to unite them into a complete, composite system which will be capable of machining parts throughout a full cycle, without human participation. The institute's specialists are developing various accessories, mechanisms and assemblies, with which individual modules will be interconnected and robots will be 'taught' to interact in a reliable fashion."

The first GPS, which is now taking shape at the test facility, is planned to be ready by the end of this year.

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BRIEFS

ULTRASOUND MACHINE TOOL DEVELOPMENTS--Moscow, 11 May (TASS)--Soviet scientists have achieved a twenty-five fold increase in the productivity of technologies using ultrasound, which today is capable of piercing figured orifices in super-hard materials, welding plastics, and much else. Scientists of the Machine Science Institute of the USSR Academy of Sciences have proposed using the principles of auto-resonance in an ultrasound machine-too, which means making the device operate within the parameters of the tool's self-oscillations and those of the material being processed. This is achieved by using an ordinary microphone which reacts accurately to any changes in the working conditions and effectively transmits ultrasonic energy. The machine-tool now works stably under any load. The scientists consider that making machines work within their self-generated oscillations, of auto-resonance, is one of the revolutionary improvements in technology. Using this principle, tens of original robots and special machine-tools have been developed at the institute over the past five years that use 50-60 percent less electricity than traditional ones. [Summary] [Moscow TASS in Russian 1203 GMT 11 May 86] Moscow May 11 TASS--Soviet researchers have increased 25-fold the productivity of ultrasound technologies used for making complicated-shape holes in extra-hard materials, welding plastics and performing many other operations. The experts from the Institute for Machine Studies at the Soviet Academy of Sciences suggested using the principle of autoresonance, that is, making the machine work in the regime of the oscillations of the tool and the material machined. It turned out that a feed-back gauge (ordinary microphone) could be fitted out to ensure that. The gauge reacts to any changes in the condition of the operation and ensures effective transmission of ultrasound energy. The machine maintains stable operation under any load. Making a machine operate in the regime of its own oscillations, autoresonance, means to achieve a breakthrough in technology, according to the researchers. Dozens of original robots and special-purpose machine tools have been designed at the institute on the basis of this principle during the past five years. Some of them consume 50-60 times less electricity than traditional machines. The future economic effect is immense considering the great number of robots, mechanisms and ultrasound equipment used in the national economy of the USSR. [Text] [Moscow TASS in English 1348 GMT 11 May 86] /6091

LENINGRAD INSTITUTE'S NEW ROBOT--Leningrad May 22 TASS--A robot devised by the Leningrad Institute of Technology of Electrotechnical Production is very formidable in appearance: It resembles a huge spider. However the four-arm manipulator, in the opinion of Soviet experts, will be an indispensable part at the city's enterprises: It will do the job of several auxiliary workers. The electronic helper is designed to charge holders feeding blanks under presses. [Text] [Moscow TASS in English V5-13 22 May 86] /6091

AUTOMATION IN ALMA-ATA--In a reportage by correspondent Dakesh Bayengetov (phon.) from the '20 years of October' machine-tool building works in Alma-Ata is said that the automation process is in full swing there; in the workshop No 1, e.g., there is almost nobody; on the right, there is a long line of new machine tools, whereas on the left, there are tools already operating, and they are operating automatically, virtually without human intervention. A similar process is going on in the other workshops: modern tools with programmed control, robotic complexes, data processing centers and automatic lines are being installed. As a result of this modernization, output of new products, i.e., screw-cutting lathes of high precision, has been started; compounds manufactured by the new machines no longer need grinding or polishing or other additional operations. The chief production-process engineer stresses the new trend towards exclusive production of machine tools of high precision; according to the pledges taken by the collective of the works, high precision machines are to make up 90 percent of the total production very soon. [Summary] [Moscow DOMESTIC SERVICE in Russian 0200 GMT 22 Jul 86] /13046

GRANAT AUTO PLANT MANIPULATOR--Minsk May 15 TASS--The Granat firm of Minsk has designed a new model of industrial robots. Specialists call it Anthropomorphiv, capable of manipulating articles and tools like a human being. But in contrast to the human hand, the manipulator robot can also unbend the elbow joint in a reverse direction and can rotate its hand. At the Minsk tractor factory, for instance, these robots will shoulder the most laborious operations of welding cabs. In the current Five-Year Plan period (1986-1990) Byelorussia will nearly quadruple the output of robots. The Granat firm with enterprises and a major scientific center has been set up for this purpose. [Text] [Moscow TASS in English V5-22 15 May 86] /13046

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PROCESS CONTROLS AND AUTOMATION ELECTRONICS

INSTITUTE DEVELOPS SURVEYING EQUIPMENT FOR SUPERDEEP DRILLING

Baku BAKINSKIY RABOCHIY in Russian No 154, 3 Jul 86 p 2

[Extract] The breadth and diversity of the geographic conditions, chiefly the geological structures, of areas which fall 'within the province' of personnel of the Southern branch of the All-Union Scientific Research Institute of Geophysical Surveying Methods (YuzhVNIIgeofizika) require flexibility in research as well as development of methods which can be to a certain extent all-purpose ones.

The potential of this institute's scientists and specialists is considerable. One proof of this is the more than 50 certificates of invention which associates of YuzhVNIIgeofizika have been awarded in recent years.

We are reporting from one of the institute's top departments--the department of geophysical research. Advanced surveying methods are now receiving the most attention here. Geological parties in our republic and Tataria are now using recommendations of the department's scientists. They are needed both for prospecting new deposits and for reaching greater depths in old areas.

Specialists of the department are working also on designing and improving equipment for geophysical surveying. And they have achieved substantial successes here. Instruments, chiefly depth gauges, were recently introduced into service in northern regions of the country, in accordance with specifications prepared at YuzhVNIIgeofizika. Specialists of the department take a certain pride in their participation in the operation of superdeep boreholes. They developed reliable equipment for one of these boreholes, which is on the Kola Peninsula. This equipment is distinguished by its durability at temperatures as high as 270 degrees and under pressures higher than 200 atmospheres.

(Two photographs are given showing T. Rodina, an associate of the institute's laboratory of new geophysical research methods, working with instruments; and senior geophysicist V. Mamedzade and V. Barlyayev, an engineer, conducting an experiment.)

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HELICOPTER INSERTS INSTRUMENT TUBE INTO DAMAGED CHERNOBYL REACTOR

Moscow PRAVDA in Russian No 195, 14 Jul 86 p 7

[Article by O. Ignat'yev, M. Odinets, correspondents]

[Abstract] The article describes an operation in which a helicopter crew lowered a tube packed with recording instruments into the damaged reactor at the Chernobyl Nuclear Power Station. The operation was planned by Doctor of Technical Sciences Igor' Aleksandrovich Erlikh. A tube 18 meters long and 10 centimeters in diameter was filled with instruments. At the top of it, where a 300-meter line was attached, there was an umbrella shaped cover, which also had instruments mounted beneath it. Inside the line attached to the tube were cables for transmitting data from the instruments. The tube had to be inserted into the reactor so that two-thirds of it was down in the reactor, with the remainder sticking out above it. Helicopters rehearsed the operation on a mock-up that was built of the reactor building. During the actual operation, three helicopters hovered above the reactor building: one flown by Nikolay Nikolayevich Mel'nik carried the tube, and the other two helicopter crews observed and advised Mel'nik on orientation. The first two attempts to lower the tube through the crust of debris covering the reactor were unsuccessful, but on the third try, the tube penetrated to the desired depth. Mel'nik then cast off the 300-meter line attached to the tube. The line was supposed to fall to one side of a wall of the reactor building, where another line that had been strung to the site could be connected to it. But the line fell to another side of the building, into a zone of heavy contamination. A member of a four-man radiation-monitoring team that was working at the site went into a corridor and pulled the line through a window to where it could be connected with the other line.

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FEEDING EXHAUST GASES TO FRICTION PARTS FOUND TO RAISE DURABILITY

Moscow PRAVDA in Russian No 195, 14 Jul 86 p 7

[Text] Scientists and designers try to increase friction in those places where it is beneficial. As a consequence, however, wear of parts such as brakes and clutches increases. Their working surfaces heat up, oxidize more rapidly, and break down. What can prevent this?

Associates of the USSR Academy of Sciences' Institute of Machine Studies and of the Ivano-Frankovsk Institute of Petroleum and Gas decided to sharply reduce the concentration of oxygen in zones where parts rub. To do this, it was decided to use exhaust gases from an internal combustion engine: they contain only one-third of one percent of oxygen, whereas one-fifth of their content is an 'antioxidant'--carbon dioxide. Comparison tests confirmed that in an atmosphere of exhaust gases, the durability of rubbing parts increases by 2-8 times.

Developing a system to feed exhaust gases to rubbing surfaces was just a 'question of engineering,' as they say. A system that is not complex was developed. Its use on the equipment of just one deep-drilling geological surveying expedition yielded an economic benefit of 27,000 rubles in one year. The authors of the invention are convinced that the use of exhaust gases can be just as effective in tractors, combines and other machines.

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AUTOMATED ASSEMBLY TOOLS; UNIFIED COMPONENTS URGED

Moscow MASHINOSTROYENIYE in Russian No 6, Jun 86 pp 15-16

[Article by V. M. Shchukin, candidate of technical sciences]

[Text] The automation of assembly processes in machinebuilding is one of the most important and complex problems of scientific technological progress. The complexity of the problem is due primarily to the large volume of fitting and finishing work presently being done in assembly processes, and moreover, it is due to the small annual volumes of output of machinebuilding products in medium and small series production; high frequency of start-ups and the unsuitability of machinebuilding product design for automatic assembly conditions. While in the first two factors neither the designer nor the technologist can have considerable influence, to solve the problem it is necessary to search for a way out only by adapting to them (for example, by using group technology methods, using the aggregation principle to create assembly equipment etc.); so that the last factor is practically entirely in the hands of designers and technologists. Until now, product design was developed without taking into account automatic assembly requirements, and this happened only because such a problem was basically not posed. The modern stage of scientific technological progress is moving this problem to a forward position.

Product designs and their planned requirements determine the sequence of product assembly on whose basis requirements are defined for the composition and characteristics of assembly equipment. If these requirements are found to be impossible to execute, the design of the product is modified with orientation toward realistically achievable characteristics of the assembly equipment.

The composition and characteristics of automatic assembly equipment depend greatly on the annual volume of output and the frequency of start-ups of the product lot being designed.

At large volumes of annual output (hundreds of thousands of items annually) and with a minimum frequency of lot start-ups, the production of the products is of a mass nature and for their assembly, as a rule, rigid (unprogramed) automatic devices (feeders, slide bars, cutters etc.) usually installed in the line are used. It should be noted that in connection with the necessity of satisfying the more frequent changing demands of consumers, freely-programable automatic machines, in particular NC robots have also now begun to be used in mass production.

With the increasing frequency of lot start-ups, the use of NC robots in assembling products becomes necessary. Comparatively small annual volumes of output in series production lead to the unavoidable concentration of assembly operations which, in an automatic assembly, is done in so-called robotized stations. At these stations one or several robots assemble certain products at a limited number of assembly positions.

Besides robots, automatic assembly systems include technological assembly equipment (presses, for example) and peripheral equipment to form regulated flows of parts and materials for assembly (for example, transportation, cutting, orienting devices etc.). One control system or multilevel control ones control all this equipment and the robots by monitoring devices.

Only with a sufficient knowledge of all the basic characteristics of these devices in the assembly system is it possible to design a product with orientation toward an automatic assembly. Frequently, however, the designer starting to develop the product does not know how it will be assembled and, therefore, what assembly equipment will be needed. In this case, when designing products it is necessary to take into account recommendation of a general nature with the accent on assembly with industrial robots. However, in this case, those recommendations that are in force for automatic as well as manual assembly should not be excluded. Such recommendations are proposed below.

Design of product as a whole. The product should be separated into independent assembly units (an assembly unit is independent if it is kinematically related and can be independently assembled, monitored and tested). The composition of the product must exclude intermediate disassembly and reassembly of its component parts. The product (aseembly unit) must contain the basic component part (detail, unit) which is the base for the installation of the remaining units and details. The design of the product (assembly unit) must permit assembly without changing the position of the basic component part. Each separated component part of the product must have a minimum number of surfaces and sites contacting other parts. The parting planes of the product should be as far as possible perpendicular to the symmetry axis of the product. The degree of interchangeability of the joined surfaces must exclude machining and lapping in assembly. The product must be made up, as far as possible, of standard component parts. As far as possible, special design component parts should be combined with standard parts into a single individual unit. Component parts of the product with different wear characteristics should not be combined into an individual unit. The design of power and communications circuits should permit their independent testing and monitoring. The product design should make possible assembly from a minimum number of directions. Component parts of the product when joined should permit a minimum number of the simplest motions (if possible a component part should be joined by a single forward motion). The product (assembly unit) should have components that industrial robots can grip easily.

The most common methods of gripping products by industrial robots are: clamping external surfaces in one section, in two sections (at one or different diameters); gripping internal surfaces; clamping two ends; gripping one

upper and one lower surface. The number of parts in a product should be minimal, while the number of fastener parts should be reduced. Sites for joining component parts of the product should be accessible to assembly tools and monitoring devices. The junction of component parts should be insured with minimum precision and quality of machining of the surfaces being joined. The variety of junction components must be reduced to a minimum. The product must be stable and be capable of being stacked, In the product assembly it is necessary to foresee the possibility of using methods and facilities that save time in making the connections. Such methods,for example, are press connections, point welding, heat methods and methods for freezing parts when joining them, joining plastics ultrasonically etc. The most efficient facilities for making joining easier are various flexible pistons, interacting with grooves in corresponding parts, clamping pins with flexible clips and other elastic components.

Design of product parts. Parts that can be bunkered because of their geometrical and physiomechanical properties must not be coupled, stick together or be joined together (a stepped shape slot excludes the coupling of slotted rings; springs with squeezed ends couple poorly with each other; projections and depressions of various widths on parts prevents their coupling; cylindrical hollow stops do not drop into each other). The shape of the part should save space when they are stacked in magazines. The part must have a maximum possible number of degrees of symmetry. When an asymmetrical part cannot be avoided it should be noted. The shape of the part should be convenient for moving in trays (the parts should not run on top of each other; they should be stable; they should be capable of rolling and sliding). The design of the part should be such as to be able to install in the product without the use of auxiliary fixtures (spacers, mandrels), and as far as possible the necessity of tilting before joining should be eliminated. This means that the part should be properly oriented beforehand and the designer should know ways and means for the automatic orientation of the parts. The part should be strong enough to stand multilayer stacking and automatic manipulation. (It is better to install manually all fragile parts which can easily braid together and deform easily). Flexible components of parts should be changed to rigid ones (for example, cable terminals should be replaced by plug couplers). The part should have a clear-cut base surface for assembly (an effort should be made to combine design, measuring and assembling bases) and surfaces which make its gripping easier by the robot (parts of one product should be adaptable as far as possible to being manipulated by one and the same gripping device). The material of the grippping surface must correspond to the proposed gripping method (for example, when gripped by a magnet). The design of the part should provide for a minimum stroke when being joined to a previously installed part.

To fix the parts being joined it is necessary to use the elastic properties of the parts more widely in the product (this leads frequently to a reduction in the number of parts in the product). To ease the joining and reduce the accuracy of positioning of the installing devices (grips of robots) parts should have entering bevels, facets and centering ledges. The facet taper angle on the shaft and in the hole should not differ by more than 5 to 15^{o} (the preferred taper angle of facets is 45^{o}, for shafts -- 10 to 30^{o} and for press fittings -- 5 to 15^{o}). The necessary gap in joining along the centering ledge is 0.02 to 0.08 mm; the length of the ledge is 2 to 10 mm. Facets 2 to 6mm long must be provided on the shaft and in the hole. The centering ledge can be made only on one of the parts being joined. It is advisable to use combinations of facets and centering ledges in presses and tight fittings.

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TWO-ANGLE ULTRASONIC FLAW DETECTOR ELIMINATES REPEAT READINGS

Moscow MOSKOVSKAYA PRAVDA in Russian No 161, 13 Jul 86 p 1

[Article by A. Yefremov]

[Extract] Cracks in pipelines and metal structures are a sore point. How can they be detected without damaging the product? This is what laboratories of the "TsNIITmash" (Central Scientific Research Institute of Heavy Machinery) Research-and-Production Association are working on as they study and apply non-destructive testing methods of ultrasonic flaw detection.

At present, an instrument consisting of a case with an ultrasonic emitter that extends from it is used for crack detection. In order to pinpoint the location and orientation of the flaw, the item being inspected must be irradiated from two different angles. The emitter, however, has a removable head with only one measurement angle. Therefore, the analysis must be performed twice.

V.I. Ryk and N.P. Razygrayev, scientists of one of the laboratories, have more than doubled the speed of flaw detection by a very simple method. They have improved the design of the instrument used. Now one removable head emits sound at two different angles at the same time. There is no more need to spend a great amount of time on repeat measurements. The monotony of the work has also been eliminated. The scientists have named their unit "Sverchok" (cricket). It is no larger than an ordinary portable tape recorder. It is lightweight and easy to use. The unit is particularly effective for use in hazardous conditions. For example, the time an inspector must spend in a chemical or polluted environment is reduced.

Even though the new unit is still only being produced in small quantities at the association's experimental plant, orders for it have already been placed by many enterprises. The innovation can be used in power-engineering machine building, shipbuilding, and the chemical and petro-chemical industry.

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OPTICAL TOMOGRAPH GIVES INSTANT HOLOGRAMS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 159, 10 Jul 86 p 4

[Text] Red laser beams pierced the dimness of the laboratory, and at the same instant the air in front of us seemed to condense and to coalesce into a strange figure made up of dark and light bands. It was alive, changing and shimmering with an eery light.

"In effect, you have seen the invisible," explained Candidate of Physical-Mathematical Sciences G. Vishnyakov. "How drops of clear, cold water sink into water which is just as clear, but warm, forming eddies and currents. These experiments provide a key to an understanding of the mixing processes of layers of water in the ocean, on which, as is known, the variability of weather depends."

The holography unit developed by G. Levin and G. Vishnyakov, associates of the research-and-production association VNIIOFI, makes it possible to penetrate into an outwardly unnoticeable phenomenon and to isolate any layer of a transparent object, in a way similar to how a computer tomograph explores the brain and peers below the ground.

"The laser beam shines light through an object from different directions at the same time," said G. Levin, "and produces an entire set of holograms. Later on, the computer analyzes them and plots the phenomenon taking place."

"Yes, but we saw the interference image immediately, and not later on..."

"We were able to replace the digital computer with an optical one," explained the scientist. "With a system of lenses and mirrors, 'information processing' takes place literally at the speed of light."

The 'optical tomograph'--this is the name given by the scientists to their invention--gives, of course, only an approximate picture of a phenomenon. But its accuracy is quite sufficient for dynamic study of processes that before were inaccessible to the eyes of experimenters. The mixing experiments are but one example of the use of the unit. One can also peer into a flame, see how hot bodies radiate heat, how air flows around an airplane model or a turbine blade, and much more. Scientists have acquired another powerful tool for expanding knowledge.

(A photograph is given showing G. Vishnyakov.)

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